THE Petroleum Engineer

JANUARY 1935

VOLUME VI NUMBER IV

A MAGAZINE OF METHODS FOR OPERATING MEN

This Issue Contains

DRILLING AND PRODUCTION

	Page
Parallel Operation of Electric Generators — By W. C. Lane	18
Controlled Directional Drilling — By J. C. Albright	21
Pressure-Time Chart Taken During Cementing Provides Valuable Well Record — By Wallace A. Sawdon	27
Flow Line Dehydrator in California	30
How to Save Belting — By W. F. Schaphorst	38
Elements of Applied Petroleum Production — By K. C. Sclater	55
Complete Specifications of New Portable Rotary Drilling Unit — By Carl White, Jr.	86

REFINING AND NATURAL GASOLINE MANUFACTURE

The Optimum Economic Design of Unfired Pressure Vessels Graphically Calculated in Accordance With the A.P.I.-A.S.M.E. Code — By M. E. Clawson and T. O. Duller	40
Elements of Applied Petroleum Refining — By W. L. Nelson	62

OIL AND GAS TRANSPORTATION

Maintenance of Equipment in Electric Pipe Line Stations — By Frank H. Love	24
A New Outlet for San Joaquin Oil	32
Elements of Applied Petroleum Pipe Line Transportation — By Emory Kemler and L. L. Thomas	58

GENERAL

Orifice Meter Maintenance — By G. B. Steele	51

REGULAR DEPARTMENTS

The Course of Oil	9
Highlights in Oildom	10
Latest Activities in the Oil Fields	12 and 13
Progress of Major Pipe Line Work	15
The Month's Activities in Refining	17
New Petroleum Equipment	68, 69, 70, 72, and 73
Running Tour With Men in the Industry	74
Laugh With Barney	76
Trade Literature	82
Book Reviews	84

Meetings

California Natural Gasoline Association, Monthly Meeting —February 7, Richfield Building, Los Angeles.

American Institute of Mining and Metallurgical Engineers, Petroleum Division, Annual Meeting—February 18, 19, 20 and 21, New York City.

American Association of Petroleum Geologists—March 21, 22 and 23, Wichita, Kansas.

Petroleum Industry Electrical Association—April 11, 12 and 13, Baker Hotel, Dallas, Texas.

American Chemical Society, Semi-Annual Meeting — April 22, New York City.

Natural Gasoline Association of America—May 1, 2 and 3, Tulsa Hotel, Tulsa, Oklahoma.

American Petroleum Institute, Fifth Mid-Year Meeting —May 14, 15 and 16, Mayo Hotel, Tulsa, Oklahoma.

Pennsylvania Grade Crude Oil Association, Annual Meeting — June 20 and 21, State College, Pennsylvania.

American Society for Testing Materials, Annual Meeting —June 24, 25, 26, 27 and 28, Book Cadillac Hotel, Detroit, Michigan.

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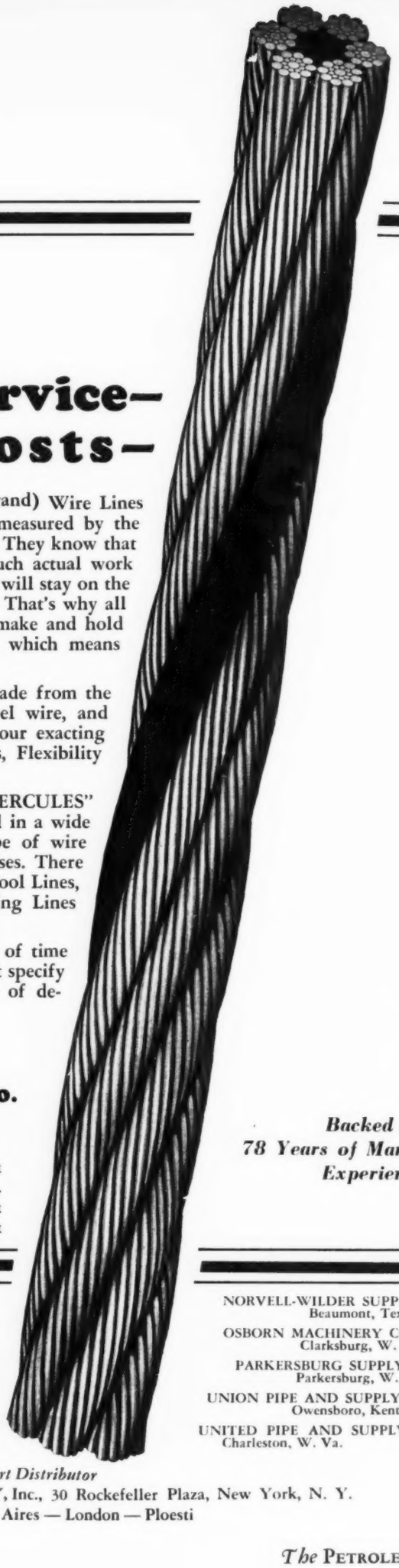

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The Course of Oil

By K. C. SCLATER

1934 and the Year Ahead Judged by ordinary standards, 1934 in the petroleum industry was an abnormal year. There are definite indications that it marks the beginning of a new chapter in the history of petroleum. A realignment of world markets has been, and still is, taking place.

During the first nine months of 1934 the crude petroleum production of the world increased sixty million barrels. Only four million barrels of this increase was produced by the United States.

Several months ago oil from the potentially prolific fields of Iraq began to flow through the newly-constructed Iraq pipe line, the terminals of the two branches of which are on the eastern shores of the Mediterranean, relatively close to European centers of industry and potential markets. Last July, with the completion of pipe line and tanker loading facilities, crude petroleum from Bahrein Island in the Persian Gulf began to find its way into the channels of world commerce.

Important discoveries of petroleum deposits were made in foreign countries, particularly in Russia, South America, and French Morocco. In the United States the only discovery during the year that might be classed as of major importance was the Fitts pool in Oklahoma; many new fields of minor proportions were opened up but large discoveries of any consequence were conspicuously lacking.

Although the production of oil has been under curtailment in the United States, prospecting has been active throughout the year. During 1934, in the United States, some ninety to ninety-five seismic crews, forty to forty-five torsion balance crews, five to seven pendulum crews, one to three gravimeter crews, and ten magnetometer crews were employed in geophysical prospecting by the oil industry at an annual cost of some nine to ten million dollars. A program of this magnitude presages a return to more normal activities in the development of new fields during 1935.

As a result of the program of restricted production, and despite the flow of "hot" oil in East Texas, the petroleum industry starts the new year in a statistically sounder position than it has been in in years. With a continuance of the control of production exercised during the last quarter of the year there is promise of a good year ahead.

The Key to Stability The East Texas field remained a center of interest throughout 1934; this because of the important place it still continues to occupy as a large potential producer of oil. With the first week of 1935 comes renewed anxiety over this gigantic petroleum reserve.

An adverse decision of the Supreme Court of the United States on January 7, 1935, declared Section 9(c) of the NIRA relating to oil unconstitutional on the grounds that Congress delegated unlimited legislative powers to the executive branch of the government. The industry has become alarmed, perhaps unduly so, lest an orgy of illicit oil production breaks out.

Meanwhile, measures to speed up legislative action have been taken. President Roosevelt is reported to have asserted that a mere correction of wording will cure the defects in the law. At this writing, the necessary passage of legislation to remedy the law without delay seems assured.

During the year some 3600 new wells were completed as producers, bringing the total number of producing wells in the East Texas field to 15,849 at the close of 1934. The average allowable per well, as a result of these additions, was reduced from 34 barrels in January, 1934, to 27 barrels in January, 1935. Of the 46 wells completed in the field for the week ending December 30, 1934, 12 fell in the marginal class. This brings the official total of marginal wells in the field to approximately 2220 at the close of 1934.

During the last three months of 1934 there was virtually no overproduction of oil in the field. This is now being reflected in reservoir pressure. Bottom-hole pressures are building up in some parts of the field, probably due to equalization of the reservoir pressure.

In this field the reservoir pressure is greatly influenced by the rate of withdrawal. Research engineers of the Humble Oil and Refining Company have estimated that were the East Texas field produced at a rate of 400,000 barrels a day, the average reservoir pressure drop for the field would be less than two-tenths of a pound per million barrels of oil produced. This estimate is based on a study extending over several years and takes into account the mechanics of the water-drive and its influence on the reservoir pressure. The present average reservoir pressure in the field is approximately 1250 pounds. Assuming an average withdrawal of 400,000 barrels a day for 1935, the average reservoir pressure a year from now should still be greater than 1200 pounds. But will the rate of production be held to this amount?

Statistics of Exhaustion The Cole committee has submitted to Congress an impartial and highly constructive report, one that is quite in keeping with the manner in which they conducted their investigations. Here is one of the significant statements that appears therein: "Statistics of production are also statistics of exhaustion. No one knows how much petroleum there is underground in America. We take the broad position that whether our petroleum supplies are large, or small, they should not be physically wasted above or below the ground. Cheap and abundant fuel as power are the very cornerstone of American industry, transportation and business. The people who predict abundant petroleum reserves fifty, or one hundred years from now, do not give bond for the accuracy of their estimates."

« « « HIGHLIGHTS IN OILDOM » » »

Section 9-C of NRA Held Unconstitutional

The United States Supreme Court on January 7 ruled unconstitutional Section 9(c) of the National Recovery Act, under which the federal government is attempting to control oil production. Chief Justice Hughes read the opinion, which held that Congress had delegated too much legislative authority to the president when it gave him power to prohibit the interstate shipment of oil produced in excess of state quotas. The opinion was given in the case brought by the Panama Refining Company and the Amazon Petroleum Corporation, challenging the validity of the recovery act. Previously the Federal District Court had ruled against the government, while the Fifth Circuit Court of Appeals held the opposite view.

Since the court's decision the administration has taken steps to enact legislation designed to control the interstate shipment of oil. Senator Connally of Texas has introduced in the Senate a bill making illegal the interstate shipment of crude or products of crude in violation of state laws, and giving the president authority to make rules and regulations to carry the resolution into effect. Representative Disney of the Tulsa, Oklahoma, district on the same day introduced a bill in the House to take the place of Section 9(c). The bill makes declaration of conservation policy and is confined to interstate shipment of oil or its products produced in violation of the state law, with power of enforcement given the president somewhat similar to the Connally bill but with far heavier penalties. Senator Gore of Oklahoma has given notice in the Senate that he also will offer a bill to cope with the Supreme Court's decision. He would apply the Webb-Kenyon law to interstate shipments of oil and its products the same as intoxicating liquors. The president would be authorized to determine whether the law is being violated and through designated agents to issue proclamation to prohibit such violations.

●

Oil States Favor Interstate Compact

At a conference in Ponca City, Oklahoma, January 3, representatives of eight oil producing states went on record as favoring an interstate compact for the regulation of the petroleum industry. A resolution was adopted unanimously requesting Congress to pass legislation permitting the oil producing states to enter into an interstate compact for the conservation of petroleum and the prevention of waste of this natural resource; and also that the legislatures of the various oil producing states be submitted a bill authorizing representatives of the states to meet and adopt a compact for carrying out this purpose.

The states represented at the conference, either by their governors, governors-elect, or other representatives, were Oklahoma, Texas, Kansas, Louisiana, Arkansas, New Mexico, California, and Illinois.

Action was speeded up at the conference by receipt of telegrams from William P. Cole, Jr., chairman of the subcommittee of the Interstate and Foreign Commerce Committee, which recently completed an investigation of the petroleum industry, in which he stressed the importance of the states taking action to govern the industry by means of an interstate compact. In part Mr. Cole's message read: "We strongly urge upon the oil producing states the adoption of state compacts to deal with the problems of the production of petroleum with which individual states are powerless to cope. The subcommittee clearly realizes the principle of state compacts for the purpose of effecting a common end of state interests. Other plans for dealing with the problems of petroleum production outside of state lines are full of constitutional questions. State compacts, flexible in operation and over which the president of the United States or a federal agency in the interest of the consuming masses of the nation may hold some veto power, is an ideal solution of those problems of petroleum production which cannot be solved by modification of the 'law of capture' and other legislation operating within state boundaries."

●

Cole Committee Makes Report

The Cole investigating committee, appointed to study the oil situation, made its report on January 3. The committee made no definite proposal as to legislation that should be enacted, explaining that the decision of the Supreme Court in the Amazon and Panama cases, the outcome of the governors' conference on an interstate compact (neither of which were known at the time the report was made), and the report of the national resources board dealing with minerals, should be awaited. When the results of these activities are made known the committee will ask permission to make a supplemental report in which will be contained recommendations for any legislation that is believed needed, it is said.

A portion of the report stated: "Any legislation establishing permanently the interest of the federal government in the petroleum industry should provide for an agency, commission, or board to absorb some of the activities in the various departments of the federal government as now constituted. The Bureau of Mines might very easily be revamped for the purpose." This statement indicates that the Cole committee does not favor leaving control of the oil industry in the hands of the oil administrator and the Petroleum Administrative Board.

The committee also believes both federal and state legislation is needed to strengthen existing laws in respect to prevention of waste. Confidence was expressed in the results of the governors' conference. State compacts were urged as an "ideal solution" of the oil industry's problems.

●

State Loses Oil Deduction Tax Suit

Federal Judge Edgar S. Vaught has handed down a decision at Oklahoma City enjoining the state from collecting taxes on the three per cent of crude oil production allowed for deduction. In making the decision Judge Vaught upheld the contention of the Stanolind Crude Oil Purchasing Company and other Mid-Continent purchasers that the custom of many years' standing of making a three per cent deduction for shrinkage and waste is legal. The state tax commission opposed the custom, sought to set it aside, and had instituted suit to collect back taxes from 1931.

In his opinion Judge Vaught held that the tax was on the value, and that the value of the oil was the price a willing purchaser would pay and a willing seller would accept, based upon any measurement agreed to by both.

●

Injunction Granted in Wilshire Case

Judge McCormick of the United States District Court has granted the government's request for an injunction restraining the Wilshire Oil Company of California, and its subsidiaries, from distributing petroleum products in excess of the quota established under the NRA code. The injunction remains in effect until the court has had an opportunity to hear the case.

The case will test the right of the federal government to fix an oil production quota for California. The Wilshire Oil Company maintains that its entire operations are within the state limits of California and therefore not subject to federal regulation.

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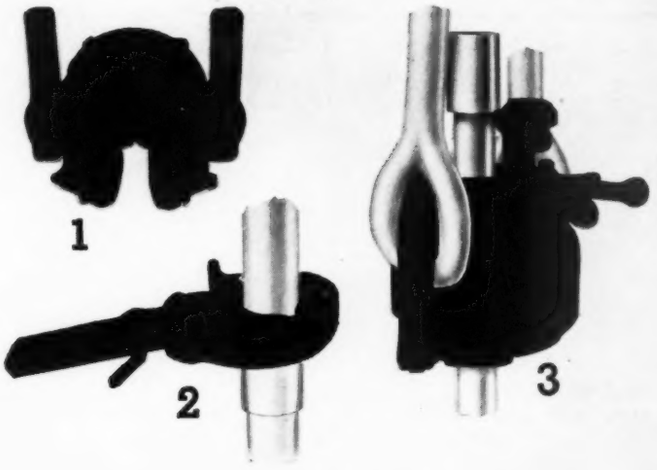

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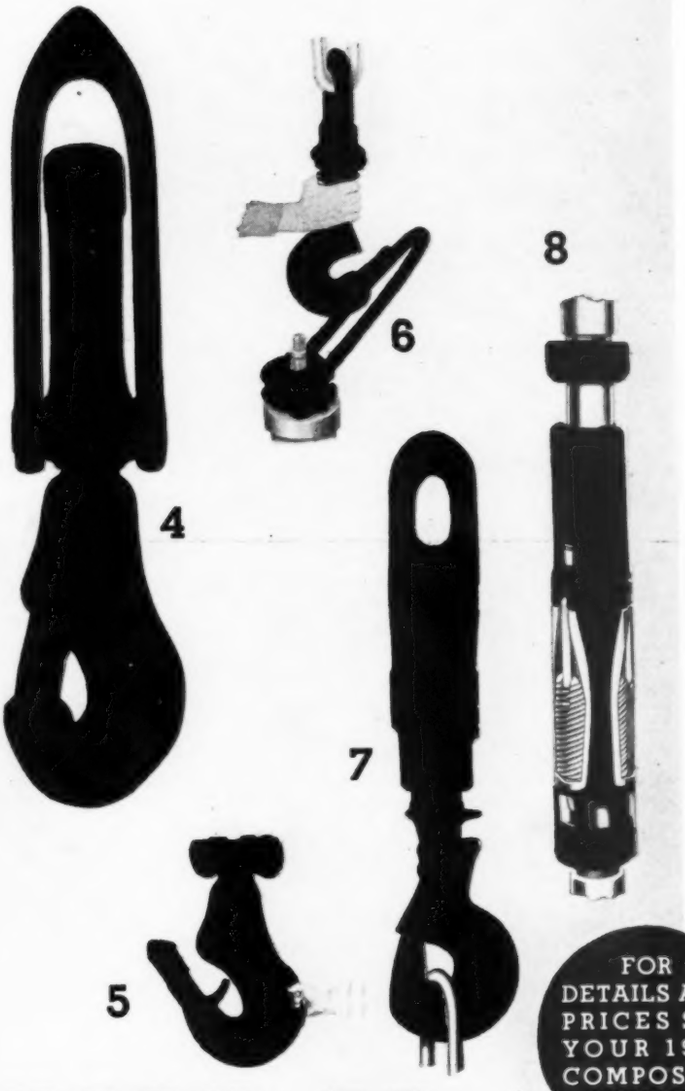

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3 BJ Center Latch Slip Elevators do not lift under the coupling, but the load is carried on four long slips which are set automatically by simple positive mechanism.

4 BJ Tubing Hooks are made in 3 sizes for 30, 50 or 75 tons of tubing. The "locking arm" provides a closed C-link action and prevents elevator bails from "jumping" the hook.

5 The locking-arm on all BJ Hooks guides the hook in picking up the elevator links, which close and lock the hook when the load is taken.

6 BJ Rod Hooks in sizes to handle 10, 15 and 20 tons of rods offer convenience and safety never before possible. Note how the hook is guided through the bail of the BJ Rod Elevator, and how the bail is supported for a quick pickup.

7 And here is a "spring" rod hook — the BJ "20" ready for fast, safe handling of the longest strings of rods ever run. Note the streamlined design and the lubrication connection.

8 BJ Surestop Tubing Catchers do not hang-up while running-in and are not set by gas pressure or heavy fluid. Extra large slips set positively without damage to casing. Ask us to explain the advantages of "anchoring" tubing.

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LATEST ACTIVITIES IN THE OIL FIELDS

SEVERAL new pools were discovered in Texas during the last month. The Gulf Production Company found oil in Pecos County with its No. 3 White and Baker well, which was completed at a total depth of 1826 ft. and made 27½ bbl. of oil daily. Two new fields have been added to Duval County. Approximately two miles east of the Government Wells field the Humble Oil and Refining Company found production at a total depth of 2790 ft. with its No. 1 Ruiz test. Mills Bennett's No. 1 Duval County Ranch, five miles west of the Government Wells field, is a gasser, making 15,000,000 cu. ft. per day. It was drilled to a depth of 3006 ft., plugged back to 1280 ft., whipstocked, sidetracked, and drilled to 1505 feet. Another Pettus sand field has been opened in Bee County by Dirks Brothers with their No. 1 J. E. Roth, two miles west and north of production in the West Tuleta field. The well flowed 286 bbl. of oil daily through ¼-in. choke at a total depth of 3884 feet. The discovery is looked upon as a new field rather than an extension of the West Tuleta area. In Brazoria County another field was added to the Texas Gulf Coast area by the Stanolind Oil and Gas Company's No. 1 J. W. Surface, which is producing from sand at a total depth of 5990 feet. W. J. Rhodes, Breckenridge operator, opened a new pool in Shackelford County with his wildcat well No. 1 George Ray, drilled to 1647 feet. The well made 40 bbl. daily on the pump.

●

Commercial production has been definitely proved for Scott County, Kansas, by the Atlantic Oil Producing Company's No. 1 Mary E. Vaniman, 12 miles south of Scott City and 100 miles from the nearest production. The well pumped 572 bbl. of oil with no water after being treated with 1000 gal. of acid. Production is from the Mississippi lime at a total depth of 4686 feet.

●

A new pool has been found in Ouachita County, Arkansas, approximately eight miles west of Camden. T. J. Gaughan et al's No. 1 M. Bragg was completed recently as a pumper, producing 100 bbl. of crude daily from the Nacatoch sand at a total depth of 1394 feet.

The Ramsey Petroleum Corporation's No. 1 Weightman, a wildcat on the Last Chance Creek structure near Castledale, may open an oil pool in Utah. The test topped the Kaibab, a Permian lime, at 3071 ft. and had a showing of light oil. The test is now drilling deeper. At 2742 ft. 30,000,000 cu. ft. of wet gas was had.

●

The Fish Extension pool, five miles southwest of Holdenville, Oklahoma, has been extended into Hughes County with the Champlin Refining Company's No. 2 Juddie Wolfe finding production in the Viola lime. At a total depth of 4130 ft. the well made 300 bbl. daily, and was drilled ahead toward the Wilcox with production in that formation expected at approximately 4181 feet.

●

The Carter Oil Company's No. 1 Fowler, a wildcat five miles southwest of Newkirk, Oklahoma, in Kay County, got a good showing of oil and gas when it penetrated the Bartlesville sand at a depth of 3566 feet.

●

A new shallow field in the Annona chalk in DeSoto Parish, Louisiana, was seen as a possibility when Jack Dempsey and Bobby Manziel's No. 1 Thigpen, five miles north of Mansfield and approximately four miles south of the Holly field, was brought in flowing ten bbl. of oil per hour after being acidized. After producing 100 bbl. the flow declined and swabbing was resorted to.

●

The Superior Oil Producing Company's No. 1 A. Martinez in the Bosco field, St. Landry Parish, Louisiana, is the first test to be drilled on the Gulf Coast to a depth in excess of 10,000 feet. When the test was shut down January 4 to mix mud it had reached a total of 10,002 feet. Drilling started July 26. At 10,002 ft. it was reported that the well was trying to blow out; however, it was believed that salt water was thinning the drilling mud, and it was the intention to continue drilling as soon as more weight had been added.

AVERAGE CRUDE OIL PRICES

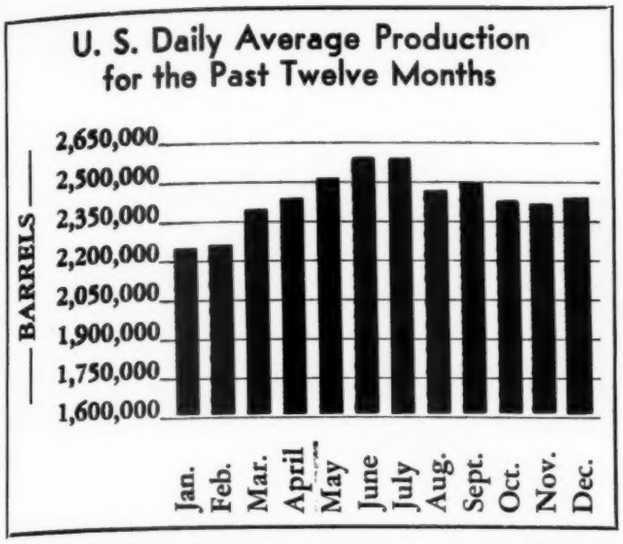
California		Louisiana	
Playa Del Rey	$ .90	North Louisiana	$ .95
Coalinga	.81	Gulf Coast	1.04
Signal Hill	1.12	Illinois	1.13
Montana	1.35	Kentucky	1.08
Wyoming	1.00	Indiana	1.12
Colorado	1.00	Ohio	
New Mexico	.75	Lima	1.30
Texas		Michigan	1.02
North Central	.95	Pennsylvania	
Panhandle	.83	Bradford	2.20
West Texas	.70-.75	Southwest	1.87
Gulf Coast	1.04	Eureka	1.82
Darst Creek	.87	Buckeye	1.72
East Texas	1.00	Corning	1.37
Kansas	1.00	West Virginia	1.67
Oklahoma	1.00	Canada	2.10-2.17
Arkansas	.70		

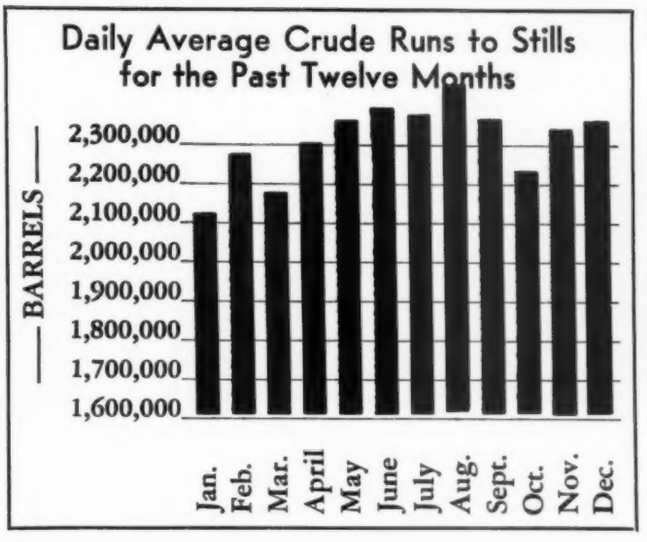
DAILY AVERAGE CRUDE OIL PRODUCTION

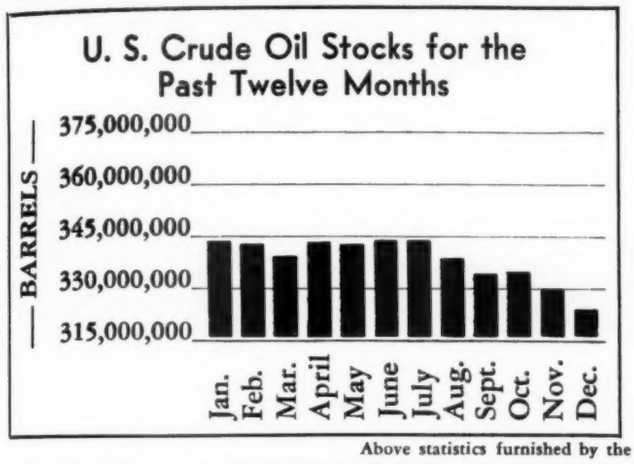
(Figures in barrels)

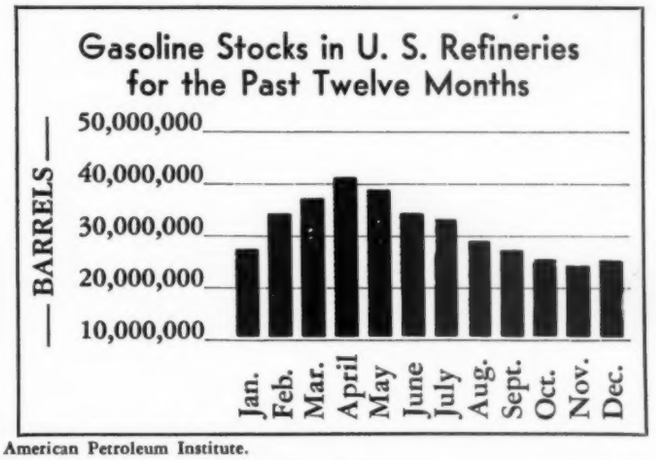
Furnished by A.P.I.

	Federal Agency Allowable Effective Dec. 17	Week Ended Dec. 29, 1934	Week Ended Dec. 1, 1934	Week Ended Dec. 30, 1933
Oklahoma	489,300	469,200	463,600	395,450
Kansas	137,100	142,750	127,300	109,850
Panhandle Texas		61,150	59,800	40,400
North Texas		57,550	54,400	57,450
West Central Texas		26,400	27,500	23,950
West Texas		155,800	138,800	119,600
East Central Texas		46,400	43,100	43,250
East Texas		419,400	413,200	406,800
Conroe		46,150	37,900	55,500
Southwest Texas		54,650	61,150	40,600
Coastal Texas (Not incl. Conroe)		130,000	126,100	103,450
TOTAL TEXAS	1,006,800	997,500	961,950	891,000
North Louisiana		23,900	24,000	26,200
Coastal Louisiana		85,400	82,850	42,050
TOTAL LOUISIANA	99,700	109,300	106,850	68,250
Arkansas	31,000	34,300	31,150	32,300
Eastern (Not incl. Michigan)	96,100	98,550	108,550	89,500
Michigan	28,100	27,700	26,900	27,300
Wyoming	35,700	35,050	36,650	29,400
Montana	9,300	12,050	11,900	6,000
Colorado	3,500	3,150	3,200	2,400
TOTAL RK. MT. ST.	48,500	50,250	51,750	37,800
New Mexico	49,800	44,850	45,750	42,000
California	473,900	466,300	448,900	446,400
TOTAL U. S.	2,460,300	2,440,700	2,372,700	2,139,850









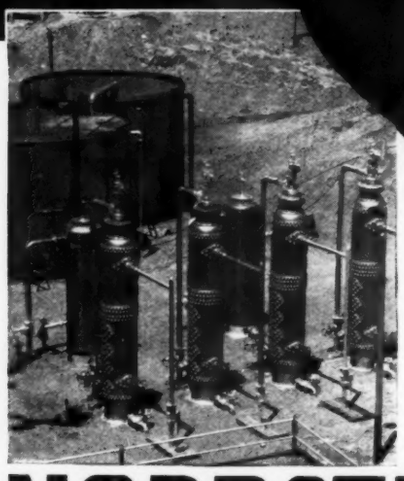
Above statistics furnished by the American Petroleum Institute.

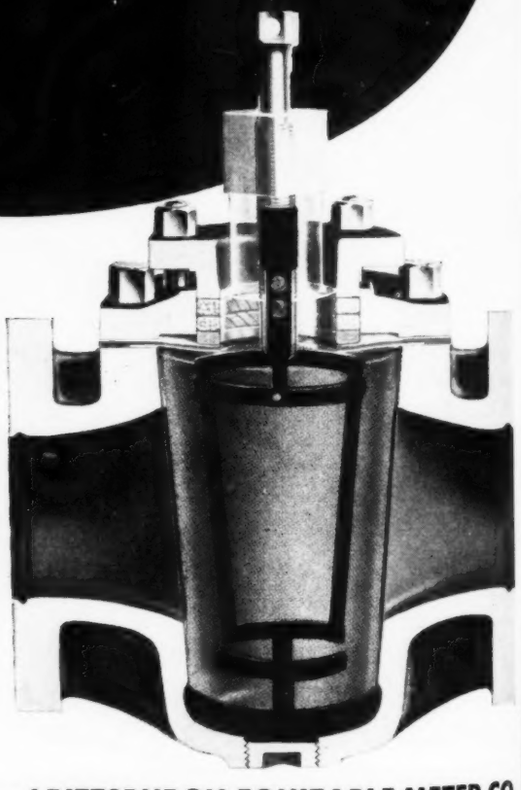
Summarized Operations in Active Fields for December, 1934

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	286	282	98	174	3600	2	40	Rotary
Duval County	18	16	3	13	2300	2	22	Rotary
Archer County	54	37	15	45	660–1800	1 or 2	40	Rot.-Cab.
Conroe	5	4	0	2	3000–7400	3 or 4	40	Rotary
Refugio County	11	9	3	6	5200	2	38	Rotary
Oklahoma								
Oklahoma City	4	2	15	31	6500	3	39	Rotary
Osage County	16	9	22	45	380–2850	2	37.5–40	Rot.-Cab.
Kansas								
McPherson County	5	2	5	27	2900–4300	2	38	Rot.-Cab.
Ellsworth Arch	20	23	19	84	3300	4	37	Cable
California								
Kettleman Hills	3	3	3	28	8300	3 or 4	40	Rotary
Long Beach	6	6	5	39	7000	3	36	Rotary

Field Activities by States for December, 1934

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1933 (In Barrels)
	December	November	December	November	December	November	December	November	December	November	
Arkansas	14	8	5	3	21	15	17	7	42	34	11,682,100
California	44	65	39	62	79	70	81	64	226	208	173,126,800
Colorado	2	3	1	2	....	....	5	5	26	33	954,900
Illinois	3	2	1	1	....	....	11	13	9	9	4,250,000
Indiana	12	28	9	18	....	....	2	2	52	55	730,000
Kansas	66	79	47	56	88	119	42	48	192	196	41,927,700
Kentucky	15	43	9	28	....	....	2	2	22	17	4,610,000
Louisiana	64	69	41	43	48	54	54	63	151	174	24,487,800
Michigan	26	44	17	27	42	34	103	96	169	151	7,790,800
Mississippi	4	....	1	....	....	....	2	4	13	12	Gas. Prod.
Montana	10	14	10	9	....	....	7	8	46	56	2,128,700
New Mexico	19	20	15	16	....	....	9	10	79	69	13,086,600
New York	....	....	....	....	....	....	1	2	3	9	3,150,000
Ohio	124	107	81	85	....	....	51	59	211	201	4,300,000
Oklahoma	148	160	84	115	169	213	103	63	462	478	181,133,200
Pennsylvania	12	14	10	11	....	....	22	16	89	94	12,690,000
Texas	746	742	571	546	1061	887	447	375	1107	970	396,993,600
West Virginia	55	40	43	29	....	....	23	25	89	95	3,825,000
Wyoming	3	8	3	6	....	....	9	8	74	82	11,211,000
Total	1367	1444	987	1056	1508	1492	980	901	3088	3074	898,078,200





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PROGRESS OF MAJOR PIPE LINE WORK

THAT the Lone Star Gas Company, Dallas, Texas, is considering the possibility of constructing a pipe line from the Long Lake gas field in Anderson County, Texas, to Dallas, has been revealed by Frank L. Chase, vice-president and manager of operations. The proposed line would be more than 100 miles in length and would cost approximately $2,000,000 to construct. The Lone Star is considering the advisability of such a line, but, as yet, has reached no decision, Mr. Chase said. If constructed it probably would be a 20-in. line. At present Dallas receives its gas supply from a number of fields, including Oklahoma and the Panhandle of Texas, and whether or not sufficient gas could be obtained from the Long Lake area to make the laying of a line from Dallas to there profitable, has not been fully determined.

The Lone Star has a contract with the Texas Seaboard and the Tide Water oil companies, discoverers of the field, permitting them to take gas from the area. The same companies have a number of shut-in gassers in their Cayuga pool in northwestern Anderson County, but these are not included in the contract.

•

The Stanolind Pipe Line Company, Tulsa, Oklahoma, recently announced it would further expand its system in western Kansas by looping and this work is now going forward. From the Greenwich area in northeastern Sedgwick County an 8-in. line will be laid to the Gates pool in northern Stafford County. A 6-in. loop will extend from southwestern Russell County to northwestern Rice County; and an 8-in. line will be laid from the Bushton area of Rice County to the Brandenstein pool in western Rice County. The Stanolind Pipe Line Company has just completed construction of a booster station north of Stafford and has commenced work on a new station at Bushton.

•

The Southern Natural Gas Company has completed a 20-mile four- and six-in. welded line from Aberdeen, Mississippi, to a point near West Point, Mississippi, where it ties into the company's Monroe, Louisiana,-Birmingham, Alabama, trunk line. This addition to the system will be used as an emergency source of gas for Aberdeen, which has been obtaining its supply from the Amory field. The Amory field has but four wells, and as these have been producing since 1925, the gas supply is getting low.

•

The Pure Transportation Company has increased its pipe line terminal facilities at Bay City, Michigan, with the addition of a 30-tank car loading rack. Loading capacity at the terminal is now 60,000 bbl. daily. With the close of the Great Lakes shipping season on December 1, crude oil shipments are being made by railroad tank car during the winter months.

•

The Ramapo Gas Corporation is to construct a pipe line for the transmission of gas to Tappan, Orangeburg, and West Nyack, New York, these towns now being without natural gas. A distribution system will be installed at each of the points. The project will require approximately eight miles of steel pipe and the total cost of the work is estimated at approximately $100,000.

•

The Sinclair-Prairie Pipe Line Company has looped its 4-in. line from the Haury field to its Wash pumping station in Harvey County, Kansas. The loop is seven miles in length and parallels the 4-in. line that has been serving the Hollow pool. The terminal of the new loop is in the Haury pool, but it also permits additional oil being moved from the Hollow field.

•

The Pecos Valley Gas Company is laying a 6-in. extension from its main line at Carlsbad, New Mexico, to connect with the Jal-El Paso line 26 miles to the southeast. In so doing an emergency supply of 6,000,000 cu. ft. of gas daily is made available from the Jal field.

•

The Sun Oil Company recently completed arrangements whereby 3750 tons of 6-in. steel pipe will be received from Germany in exchange for lubricating oils. The pipe will be used in construction of a 100-mile gasoline pipe line from Marcus Hook, Pennsylvania, to tidewater on the New Jersey coast.

•

The Bell Oil and Gas Company of Tulsa, Oklahoma, has leased from The Texas Pipe Line Company 59 miles of gathering line in the Burkburnett field of North Texas. The system just leased will be connected with the company's line at Grandfield, Oklahoma, where it has a refinery. Under the terms of the lease the Bell Oil and Gas Company will take over all connections formerly held by The Texas Pipe Line Company in the area served by the system, representing approximately 800 bbl. of crude per day.

•

The State Public Utilities Commission of Michigan on December 26 held a hearing at Lansing on the Industrial Natural Gas Pipe Line Company's application for a permit to construct a gas line from the Mt. Pleasant area to Detroit. A. T. Sarkisson, head of the pipe line company, stated that if the permit is granted a line 170 miles in length will be laid from the gas area of Mecosta and Montcalm counties. Industries in Detroit would take the gas.

•

The Fern Oil Company plans to construct a 35-mile pipe line from its refinery at Thermopolis, Wyoming, to production in the Black Mountain district, it is stated. According to the report, the line will be laid early in the spring.

•

Construction of a 40-mile gas pipe line from the Chittim wells, 19 miles east of Eagle Pass, Texas, to the town of LaPryor, has been started by the N. H. Saigh Construction Company. The line is being laid for the Texas Gas Utilities Company and will connect at LaPryor with the company's trunk line that serves the Winter Garden district of the Rio Grande Valley.

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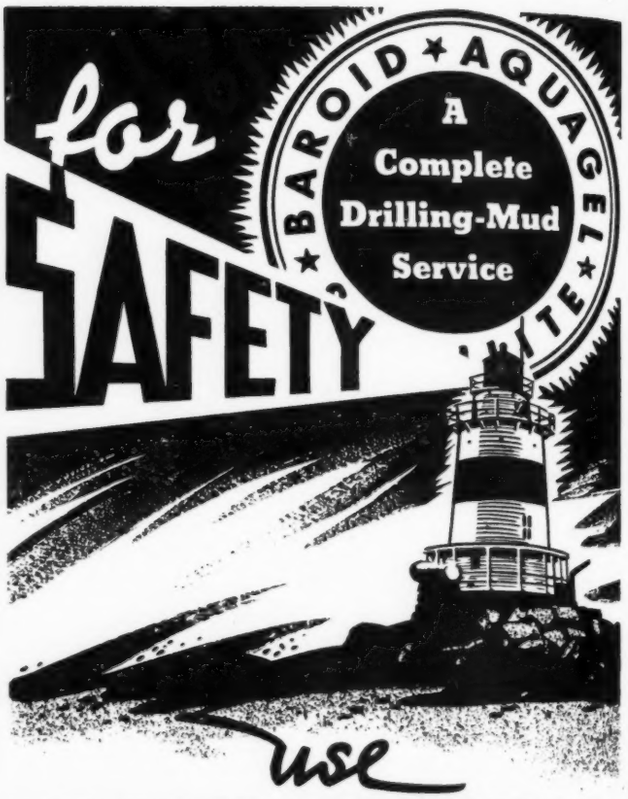

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National Pigments & Chemical Co., St. Louis

THE AMERICAN PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refining Capacity Operated

Eastern Division, 73.8 per cent **Central Division, 71.1 per cent** **Western Division, 57.4 per cent**

A 40,000-gal. refinery has been completed at Alice, Texas, and placed in operation. Emmert & Emmert of Corpus Christi, Texas, are the owners. The plant will operate on crude from Benevides, Bruni and Tuleta.

●

An 800-bbl. skimming plant has been constructed by the Phoenix Refining Company seven miles north of Abilene, Texas, near Hawley. Equipment for the plant was moved from Dallas when the Phoenix purchased the Oriental Oil Company's refinery on the Eagle Ford Road.

●

The Los Angeles Refining Company has completed a plant on Bandini Boulevard in Los Angeles that has a capacity of 2000 bbl. of crude daily. The company is a new one and the gasoline will be marketed under the trade name of Larco. Glenn Dies is manager.

●

The Capitol Oil and Refining Company, of which J. S. Higgins is head, is planning to erect a refinery in Cheyenne, Wyoming, on the site of the Hammond packing plant. The plant will operate on crude from the Osage field in Wyoming and initial capacity will be from 100 to 300 bbl. daily.

●

The Lummus Company, New York City, has been awarded a contract for the engineering and construction of a complete lubricating oil refinery for Herbert Green and Company, Ltd., London, England. The new plant, which will have a capacity of 1000 bbl. daily of finished lube oils, will be constructed at East Halton, Lincolnshire, England. The facilities will include a duo-sol plant and contact filtration and dewaxing plants.

Installation by Creditul Minier of the Gray process for clay treating of cracked gasoline, in Roumania, is proceeding in accordance with arrangements recently completed between the two companies. The Creditul Minier installation is licensed in connection with their new Dubbs cracking unit. Negotiated with Gray through their Roumanian agents, the firm of Herman Bensmann, the Creditul license is understood to be for a lump sum commuted fee, payable in monthly installments over an extended period.

From the standpoint of such operations in Roumania, the Creditul installation marks the second Gray plant to be licensed. The towers of Steaua Romana, at Campina, have been in operation since the fall of 1930. Subsequently Gray's licensing situation in Roumania, as elsewhere, has been improved by arrangements effected in 1933, whereby The Gray Processes Corporation licenses not only the Gray process, but also the R. K. Stratford (Imperial Oil) slurry clay treating method, the Osterstrom liquid phase method, and other clay treating developments of The Pure Oil Company, the Standard Oil Company of Indiana, the Standard Development Company and The Texas Company.

●

A new refinery, owned by the Europaeische Tanklager A.G., of Berlin, Germany, has been completed at Hamburg, Vice Consul C. T. Zawadski at Berlin states. The plant has a capacity of more than 2,100,000 bbl. annually and is the largest of its kind in Germany.

●

Consul Russell M. Brooks, Curacao, Netherland West Indies, announces that the refinery of the Curacaosche Petroleum Industrie Maatschappij (Shell Oil Company) at Curacao is to be enlarged. An expenditure of 12,000,000 florins (gold) during 1935 and 1936 is contemplated. The plan includes the addition of 50 or 60 tanks.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending December 22, 1934

A.P.I. Figures
(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	449,000	77.1	11,509	13,285
Appalachian	93.3	104,000	74.3	1,752	1,421
Ind., Ill., Ky.	94.6	296,000	70.1	7,097	5,327
Okla., Kans., Mo.	83.7	262,000	67.9	3,940	3,881
Inland Texas	47.6	91,000	54.5	1,193	1,680
Texas Gulf	97.5	527,000	95.5	4,779	10,691
La. Gulf	96.4	128,000	79.0	976	4,374
No. Louisiana-Ark.	83.7	45,000	58.4	210	538
Rocky Mountain	66.7	40,000	62.5	606	728
California	96.9	429,000	52.2	10,071	68,720
TOTALS WEEK:					
December 22, 1934	89.7	2,371,000	70.3	42,133	110,645
December 15, 1934	89.7	2,326,000	68.9	41,760	111,236

Parallel Ope of Electric Ge

By
W. C. LANE

On drilling rigs where alternating-current gas-electric generating units are used to supply the current for drilling, the parallel operation of generators is a subject of interest to the man in the field. In this article the author covers briefly, in a non-theoretical way, the parallel operation of both direct-current and alternating-current generators.

IT sometimes happens in industrial work that the capacity of an electric generator installed to carry a specific load is found to be inadequate. This may be due to the load being greater than was anticipated, or it may be due to an increase in the capacity of a plant and the resultant increase in the amount of equipment to be driven. Such a situation may be relieved by replacing the generator with another having a greater capacity or by adding a unit. In the latter case the load may be divided and a part of it connected to each generator, or it may be treated as a whole and the generators connected to the common load. Such a method of operating generators is known as paralleling. When they are properly adjusted each will carry a load that at all times is proportional to its capacity.

In a permanent installation it is usually the best practice to install a minimum number of generators as large units are more efficient than several smaller units of an equivalent capacity. Pumping wells, gasoline plants, and to some extent, refineries, are, however, of a transitory nature and their loads frequently increase and decrease sharply in a comparatively short period of time. Under such conditions it is more economical to install a plurality of small generators and to make provisions for operating them in parallel. As soon as the load begins to show a permanent decline units may be transferred, one by one, to other fields where they are needed.

Parallel operation may be used to an advantage on rigs used in drilling for oil with energy produced by portable d-c. or a-c. gas- or oil-electric generating units. Obviously, one large unit is more difficult to move where transportation difficulties are present than are two having an equivalent capacity. In addition to this, a plurality of units makes it possible to service one while operating the rig at a reduced rate from another. In sharing a common drilling load as in pulling pipe, a-c. generators are always connected in parallel, but d-c. generators may be operated either in parallel or in series.

In general, there are three combinations of d-c. and a-c. generators in common use in the oil country: first, the operation of self-excited cumulative compound d-c. generators in parallel; second, the operation of separately excited differential compound generators in parallel; and, third, the parallel operation of three-phase a-c. generators. The use of the first combination is usually confined to camps, gas plants and to small refineries where the load assigned is small and the power lines are short; the second is used on drilling rigs having the Ward-Leonard system of control; and the third is used in all a-c. power plants and on internal-combustion-engine-electrically-equipped a-c. drilling rigs.

In order for two self-excited d-c. generators to share a varying load in proportion to their respective capacities it is necessary for their load characteristics to be similar. For example, if a 100-kw. machine is to be operated in parallel with a 300-kw. machine the loads should be shared at all times in the ratio of one-to-three. This will be done when the machines are so designed and adjusted that whenever the smaller machine carries a certain proportion of its rated load its voltage will be the same as that of the larger when it carries the same proportion of its capacity. In placing an order for additional units the successful bidder should be advised of the type, rating, and manufacturer of the machines in service. There is no particular difficulty experienced in paralleling generators built by different manufacturers when they are given an opportunity of duplicating a specific characteristic.

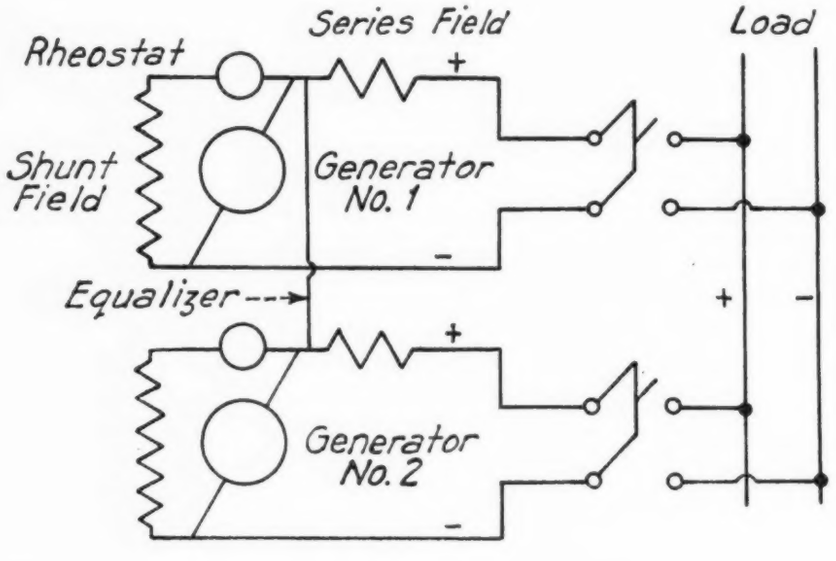


Fig. 1. Wiring diagram of two or more self-excited cumulative compound d-c. generators

peration Generators

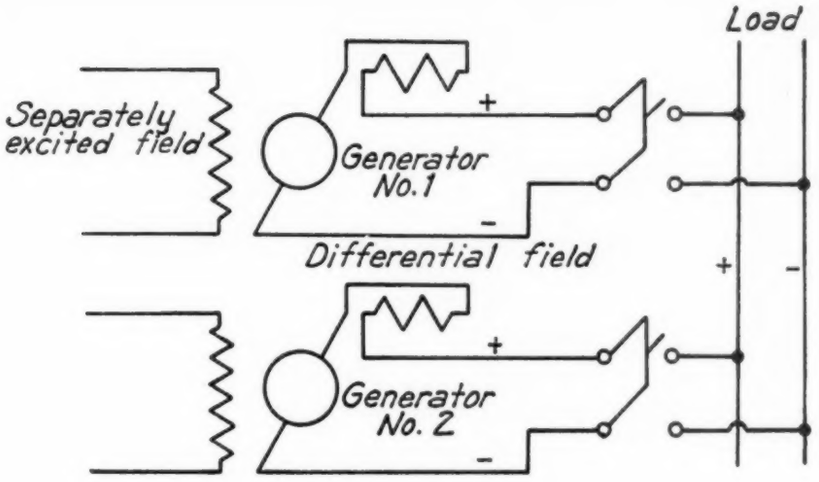


Fig. 2. Simplified wiring diagram for paralleling two or more separately excited d-c. generators on a drilling load

The method used in wiring up two or more self-excited cumulative compound d-c. generators is shown in Fig. 1. When the connections are made up for the first time and the machines are to be started the leads must be so arranged that when the switches are closed the positive terminals of all generators are connected to a common bus. Also, the series fields must be placed in the mains having a similar polarity. The equalizer connection shown prevents one generator from stealing more than its share of the load in case the speed regulation of the driving engines is not uniform. Ammeters for determining the load on each unit should be placed in the mains opposite to those connected to the series field, for if they are not they will not register the correct load. This is on account of the currents that flow in an indefinite direction in the equalizer. It seems obvious that since the purpose of the series field is to increase the voltage as the load comes on, care should be exercised to see that it acts cumulatively. The writer once ran across a unit in a small plant that had been operated for ten years as a differential generator. After the foregoing precautions are taken, all that is necessary to do is to see that the voltages are the same and to close the switch. The load is then divided by adjusting the field rheostats.

In paralleling two or more separately excited d-c. generators on a drilling load an entirely different use is made of the series winding. The simplified connections for a rig are shown in Fig. 2. It will be observed that the series fields are connected differentially so that as the load increases their effect is to lower the generator voltage. There are two reasons for using this connection: In case the governor of one engine acts the more rapidly under an increase in load the generator it drives would tend to steal the load were it not for the action of the differential field, the effect of which is to lower the voltage and cause the generator to shirk the change. This gives the slower-acting governor on the other engine time to act and cause its generator to assume its proper share of the increased load. The second reason is that it makes it impossible for a driller to overload an engine. The series coils may be so proportioned that when a certain load current is reached the output of the generator—that is, volts multiplied by amperes—no longer increases. This action, in combination with an overload relay, may be used to protect not only the engines but the generators and the drilling and hoisting motor. In operating two generators in parallel as in pulling, their field rheostats are connected mechanically and handled as a unit.

The parallel operation of three-phase a-c. generators is somewhat more complicated than the paralleling of d-c. machines. Fig. 3 is a simple wiring diagram of two low-voltage generators for supplying current to a common load. The currents in the three mains of an alternating-current generator go through a regular succession of values that are out of time with respect to one another. For this reason the first thing to be done while connecting alternators to be paralleled is to "phase them out," which means to connect them so that the flow of the current in a main of one generator will always oppose that coming from the corresponding main of the other generator. In Fig. 3, when switches are closed the two currents combine to form the current in the corresponding load line. In Fig. 3, $I_{1A}+I_{1B}=I_1$; $I_{2A}+I_{2B}=I_2$, and $I_{3A}+I_{3B}=I_3$.

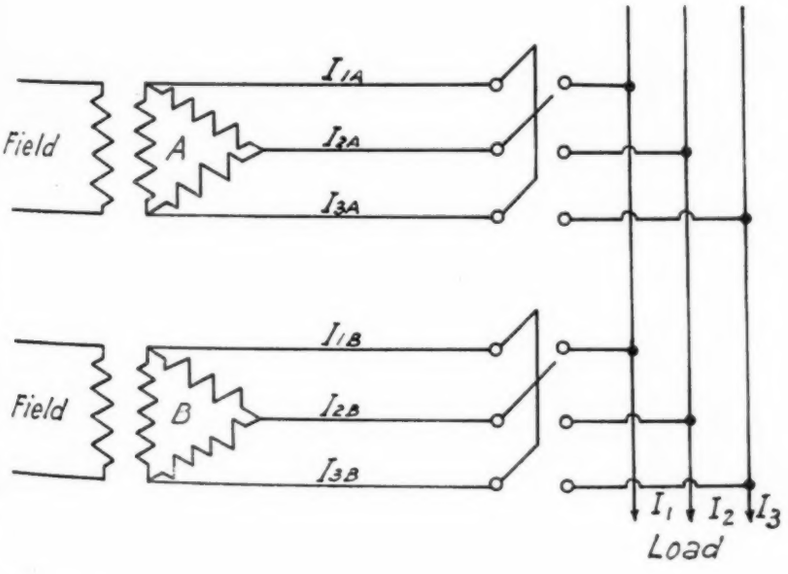


Fig. 3. Simple wiring diagram of two low-voltage three-phase a-c. generators operating in parallel for supplying current to a common load

Manufacturer's data, when available, will enable one to "phase out" two machines, but in dealing with portable units on a drilling rig that are being moved from place to place it is easy to have the cable markings lost or even changed about with mischievous intent. Fig. 4 shows a crude but very useful method of connecting two 440-volt generators for "synchronizing" them, as it is called. The synchronizing board is nothing more than a clean, dry board on which are fastened three rows of lamp sockets, four in a row. The sockets in each row are filled with 120-volt lamps and are connected in series as indicated. The first problem is to find out which leads of generator A are to be connected to switch terminals 1_A, 2_A, 3_A, on the panel board in order to oppose the currents from the second generator connected to 1_B, 2_B and 3_B. First connect the leads of the two generators at random to the posts 1_A, 2_A, 3_A and 1_B, 2_B, 3_B respectively. Bring one generator, B, up to speed, close its switch and adjust its voltage to normal. Gradually bring generator A up to speed and adjust its voltage to normal. The lamps will be observed first to flicker then to pulsate and finally to have periods of light and dark. If the three rows of lamps have light and dark periods simultaneously the machines are connected properly. If they light up and become dark at different times like a flashing sign they are wrong. The remedy is, to interchange any two of the leads going to the switch from one of the generators. The three rows of lamps will now be found to pulsate together. It is well at this stage to mark permanently the generator leads and the switch posts to which they are connected, for if once the connections are right they will always be right.

For generators to have the proper relations so that the switch between them may be closed three things are necessary: Their voltage should be the same, the frequencies identical and their phase (time relation) in exact opposition. The first condition is determined by observing the voltage of each with a meter; the second and third by observing the behavior of the lamps. When the machines are running at speeds that will generate current of an identical frequency and their phases are in opposition, all lamps will be dark and the switch may be closed. At this stage it is easy for one accustomed to operating d-c. machines in parallel to make a mistake. Increasing the voltage of an a-c. generator by changing its field current does not make it assume its portion of the load as with a d-c. unit. The prime mover of an oncoming machine must be caused to tend to speed up in order for it to take more load. Manipulating the rheostats blindly causes a useless wattless current to flow among the machines. In case it is necessary to raise the voltage of the load the rheostats of all generators should be moved in the same direction.

It is current practice to use an instrument called a synchroscope instead of the bank of lamps to indicate when it is safe to close the switch; however, on a low voltage drilling rig it is well to keep a dozen lamp sockets on hand for an emergency for guessing is out of the question when it comes to paralleling alternators. It is an excellent practice for operators that are novices from the standpoint of electrical experience to see the lamp method used occasionally as it enables them to appreciate the value of the time element in closing switches.

Two alternaters when driven by internal combustion engines sometimes fall out of synchronism when subjected to a quickly changing load by reason of the difference in the sensitiveness of the engine governors. Equipping the generators with so-called pole dampers is the remedy prescribed for troublesome cases of this kind. These are short circuited copper rings placed around the field poles or grids imbedded in the pole faces.

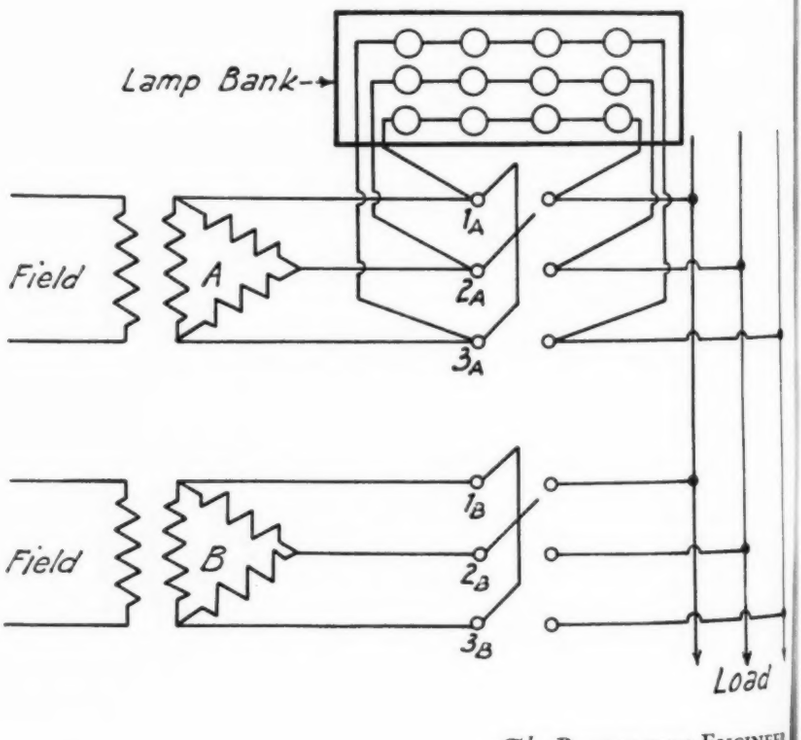
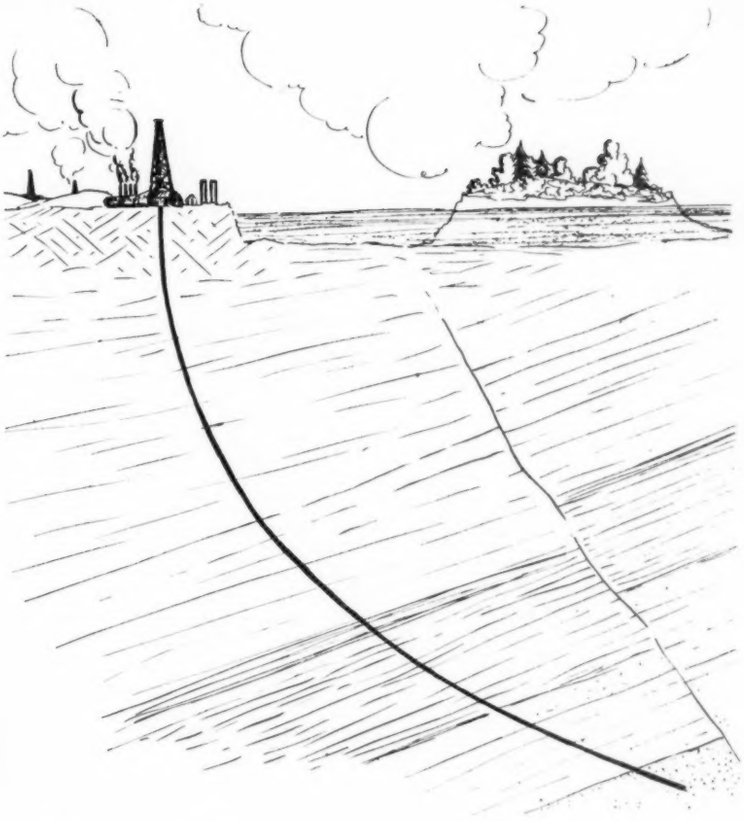


Fig. 4. Wiring diagram of a crude but useful method of connecting two 440-volt generators for "synchronizing" them

Illustrating the method used in drilling a well from the shore to a zone under a body of water



By

J. C. ALBRIGHT

Controlled Directional Drilling

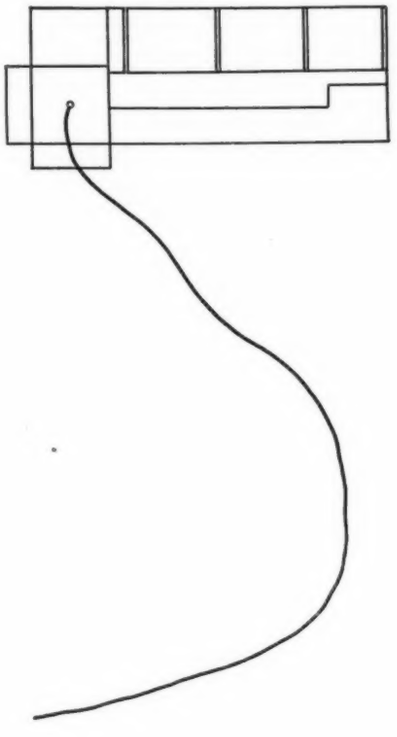
CONTROLLED directional drilling of oil wells has quite recently been reduced to a practical science to enable the producers of petroleum to complete their holes at any approximate point reasonably distant from the vertical. The methods used in completing holes by controlled directional drilling was developed in California, particularly by H. John Eastman.

No sooner had the methods been perfected so that controlled directional drilling could be accomplished satisfactorily than drilling was begun at Huntington Beach, California, on town lots not showing commercial production, for the asserted purpose of extending the productive area of that field by tapping oil reserves beneath the ocean along the beach front.

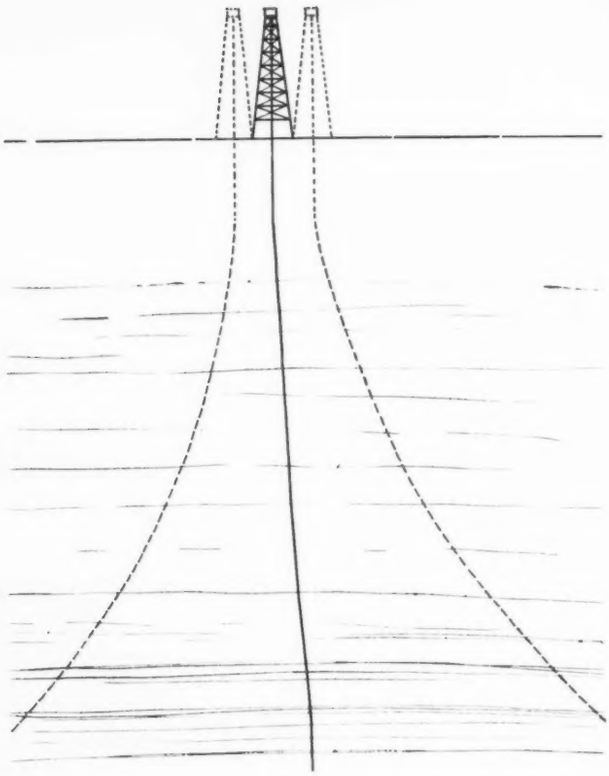
During the height of the drilling boom at Huntington Beach, more than 50 wells were being drilled by controlled directional methods. Some of these holes were drifted from the vertical to such an extent that one in particular was completed with the bottom at a point 4600 ft. horizontally from the derrick floor. The maximum drift angle brought about by controlled directional drilling was as much as 68 degrees. Many legal tangles developed in that field, not because the wells had been completed by controlled directional drilling, but because it was definitely established that oil was being removed from a productive zone under the tidelands claimed by both the town of Huntington Beach and the State of California.

In 1933, drilling in Signal Hill to tap the productive zone underlying Sunnyside Cemetery was accomplished by controlled directional methods. All the locations were made across the streets surrounding the cemetery, and some of the wells were begun and finished from locations made at distant points. Altogether during that rush, about 30 wells were completed.

One of the most spectacular controlled directional drilled holes was spudded in November 13, 1933, at Conroe, Texas. This well, the Alexander No. H-1, was begun and completed through controlled directional drilling with the express purpose of completing the hole at the same point that had been reached in the Alexander No. 1, which had run wild and cratered some months before, and could not be controlled. The relief well, Alexander No. H-1, was located 412 ft. from the crater and was drifted so that when the objective was reached, water



Path of a controlled directional drilled well as plotted from "shots"



Illustrating how three wells may be drilled from a wide pier or from locations made necessary because of surface conditions

and mud were pumped through it so that Alexander No. 1 was successfully killed. This well, Alexander No. H-1, was financed by some of the major companies, but the men and tools were furnished by H. John Eastman, who was called from Long Beach, California, to accomplish the actual drilling of the relief well by controlled directional methods.

In order to accomplish controlled directional drilling successfully, it is necessary that the company desiring the deflected hole know at what point the bottom is to be located. If the well has been begun with the object of deflecting the hole, surface pipe is set as in the usual drilling practice, and the degrees of inclination determined. One of the two different applications of controlling the drift is employed in starting the deflected hole. The formation through which the well is being drilled determines largely which application is to be utilized. If the formation where the deflection is to be started consists of shale, or other easily drilled formation, a knuckle-joint is utilized.

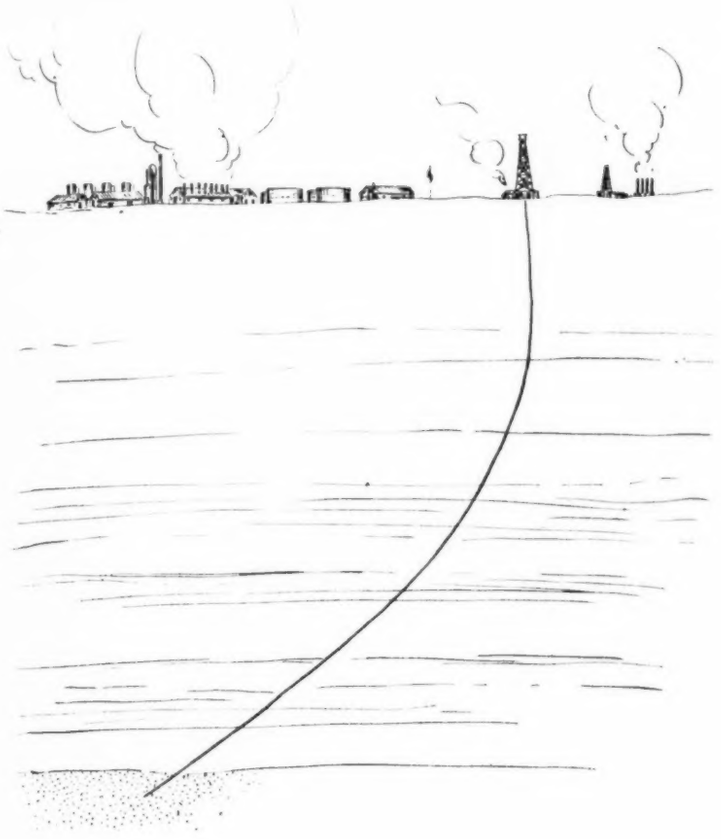
A knuckle-joint is a patented tool having a universal joint incorporated in the design immediately below a tool joint. Attached to the universal joint, and hanging downward at a fixed angle is the "stinger," which is fitted with a diamond-point four-way bit at the lower end. A reamer is built into the "stinger" near the upper end to enlarge the small hole as drilling progresses. A heavy coil spring is placed on the tool to stiffen the action of the universal joint while the tools are being lowered into the hole.

When this tool has been selected, it is made up on one or more joints of smaller drill pipe than that regularly used, to provide sufficient flexibility or limberness of the string at the lower end. To control the direction that the angle of the knuckle joint will take when it reaches the bottom of the hole, the tool is oriented in. This is done through the use of two instruments, one of which is called the "upstairs gun," and the other a transit. Each of the two instruments is attached to tapered shanks, similar to the shank on a machinist's ordinary twist drill. Clamps are used on the drill pipe, the first being placed on the top of the stand while the tools are hanging above the rotary table. The man up in the derrick attaches the first clamp so that the direction of the knuckle-joint points in the direction that the hole is to be deflected, and adjusted so that when he attaches the "upstairs gun" to a tapered hole that accommodates the tapered shank, he can sight through the gun to a predetermined target. The stand of drill pipe is then lowered through the slips until the clamp reaches a convenient point so that the engineer on the floor can attach the transit. It is trained on the common target, and record made of the angle. Each stand of drill pipe is run-in in the same manner, shooting through the "upstairs gun" and then through the transit, until the bottom of the hole is reached. Calculations made by the engineer from data recorded while the string is being lowered enable him to determine where the point of the "stinger" of the knuckle is located. When the direction has been calculated, the string of drill pipe is dropped the foot or two to stab the point of the "stinger" into the formation to establish a definite beginning.

Drilling is resumed in the usual manner with the point of the "stinger" taking the proper angle, or direction. The sharpness of the angle of deviation from the vertical is obtained and controlled by the speed of rotation and the weight applied to the rotating knuckle-joint. When the length of a joint of drill pipe has been drilled, the tools are removed from the hole and the knuckle-joint taken from the drill pipe. Either a dull fishtail follow-up bit is then used, or a fishtail pilot reamer is run. Care is used, of course, in running the new tools so that they follow through the hole made by the knuckle-joint. If the formation does not change perceptibly, or the hole appears not to be running out of hand, the hole is continued with the ordinary tools used to drill a straight hole.

If the formation presents another set of conditions when the deflected hole is begun because of

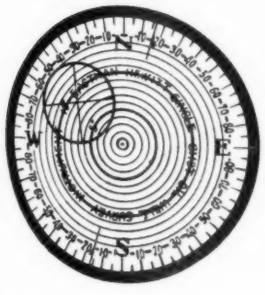
Knuckle-joint deflecting tool



Drilling a controlled directional well under a refinery or, for that matter, under any surface group of buildings

boulders or hard formation, such as limestone, etc., a whipstock is used to begin the deflection of the hole. This tool is either of heavy forged steel or is made from tough gray cast iron. In either case, the shape is the same. The upper end is fabricated with a collar, and the body gradually thickens toward the point, which terminates in a wedge so that it may be stabbed into the formation to secure it in position and prevent rotation. The whipstock is made up on the string of drill pipe by inserting the tool joint on the lower end through the whipstock collar. A special whipstock bit is then attached to the lower end of the drill pipe. The bit is larger than the collar of the whipstock and has a hole through it so that a pin may be driven through a corresponding hole in the collar of the whipstock into the hole in the bit. This is to secure the whipstock to the tools so that it will not rotate while it is being oriented into the hole. The method of orienting the whipstock is identical to that of running the knuckle-joint. When the bottom of the hole has been reached, the whipstock is secured in the formation by setting the spade-point sharply into the wall of the hole, which operation at the same time breaks the pin securing it to the special bit.

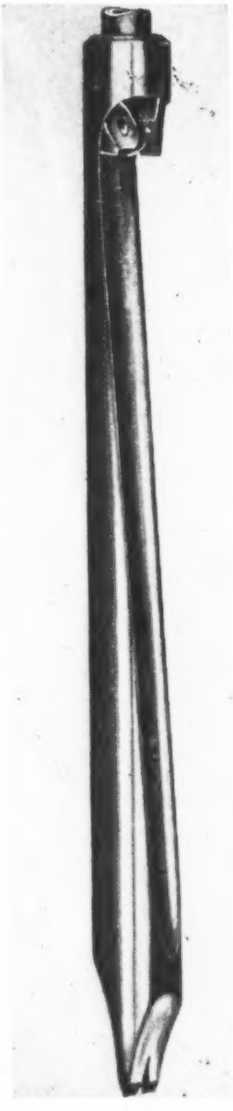
Chart obtained with single-shot surveying instrument



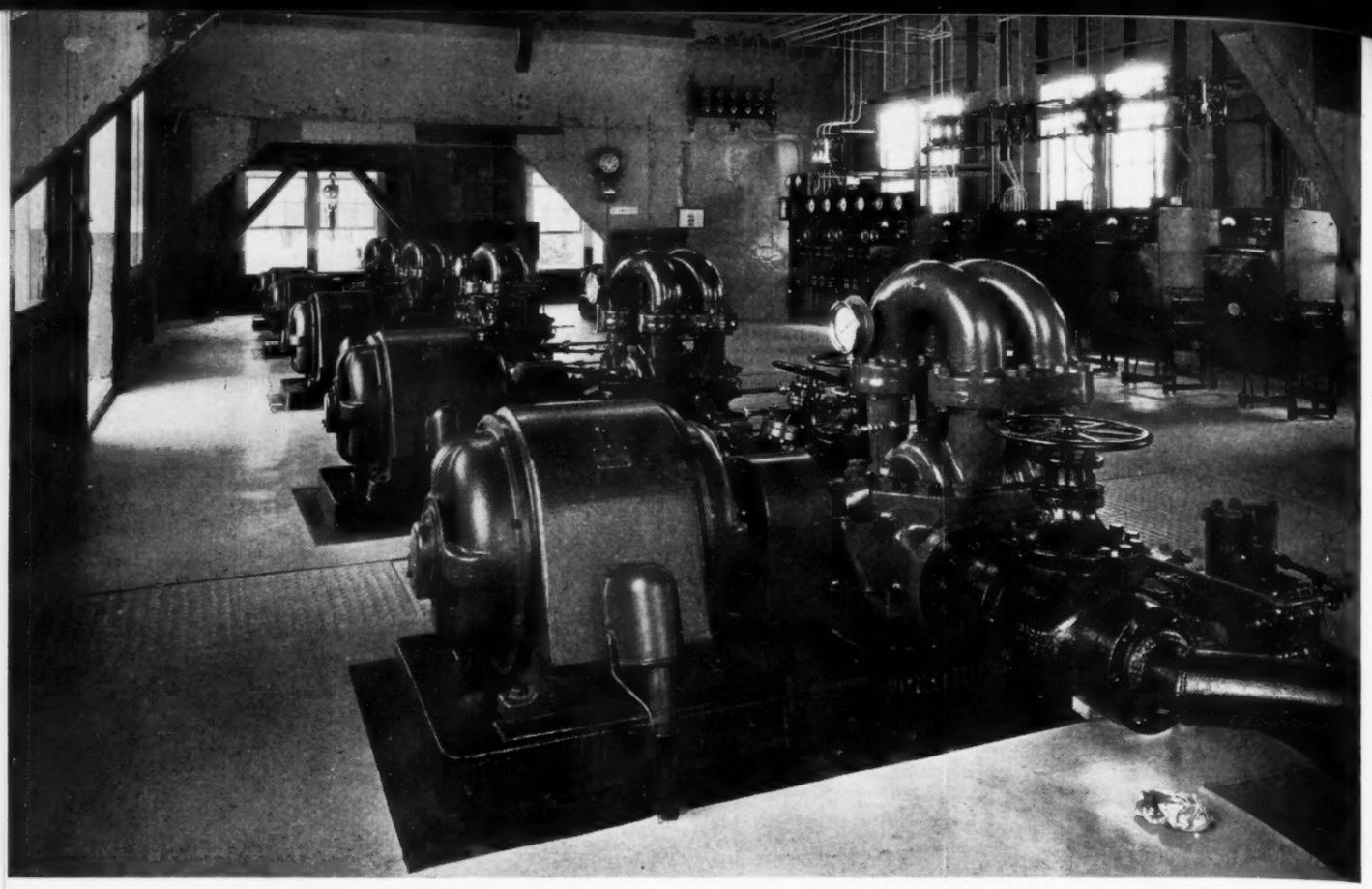
Drilling is begun in the regular manner, but by controlling the speed of rotation and the weight placed upon the bit. The whipstock is forged, or cast, with a channel on the inner side so that the whipstock bit will follow in the proper course and assume the correct angle of deviation. When not more than one length of drill pipe has been used, the tools are removed from the hole. As the special bit has a body larger than the collar of the whipstock, it removes the whipstock from the hole as the string of drill pipe is coming out.

Whether the knuckle-joint or whipstock is used in beginning the deflection in the hole, surveys are made to satisfy those in charge that the direction of the hole has been properly changed. Ordinarily, a single-shot instrument is used to survey the inclination, and it is used in the new hole once each 100 ft., or oftener, if thought necessary. This instrument is essentially a camera, but on the film is recorded only the position of the inclination element superimposed upon the image of a compass. The instrument is placed in a water-tight case and lowered into the hole, usually on a sand line, and when the proper depth has been reached, the record is made of the condition of the hole. After removal from the well, the film is developed on the location, and from the position of the image of the inclination element upon the compass, the degree of deflection as well as the direction taken by the tools can easily be determined.

Controlled directional drilling has been used to a greater extent in California than in any other locality, but the same methods may be employed in all fields where it is found expedient to drift the well from the vertical. At the present time, Barnsdall Oil Company, of California, is beginning its Tidelands No. 88-8A, which is a twin to its No. 88-8. The company will drill this well by slipping the crownblock and rearranging the rotary table, and continue with controlled directional drilling to the same productive formation penetrated by the first well.



Removable whipstock used in controlled directional drilling



Modern electrically-driven centrifugal pump station

Maintenance of Equipment in Electric Pipe Line Stations

By
FRANK H. LOVE

MAJOR pipe line companies have long appreciated the fact that proper maintenance of equipment in electric stations is of utmost importance to efficient and economical operation and, to be the most effective, the work involved in the upkeep of a station must not only be thorough but done with regularity. For this reason employees are required to follow strictly a definite program worked out by managing officials. Such a program involves, for the most part, periodic inspections and replacement of parts where needed. By diligent adherence to a schedule of this kind equipment is never allowed to deteriorate to the degree that it becomes a hazard, and the operating efficiency of the station is never seriously impaired.

The schedule followed by most companies includes a general inspection for the purpose of determining whether any new hazards involving the equipment or station have arisen since the previous check-up. Inspection is made of all contact-making devices, of the oil in the circuit breakers and compensators, switchboard panels, lighting equipment, bearing oil, tank-lighting circuits, and flood-lighting equipment. A difference of opinion exists as to how often an inspection of this type should be made. One major pipe line company is known to require it monthly, others have their operating staff make the inspection quarterly, or, in rarer instances, semi-annually. Much depends upon the type of station and the methods by which it must be operated. Field stations that are started and stopped a number of times daily require inspection oftener than main line stations that operate continuously, wear on certain equipment being more severe.

In the case of oil-immersed contact-making devices, starting compensators, oil circuit breakers, etc., bad contacts often are caused by decomposition of the insulating oils in switches, the breakdown resulting from arcing. When faulty contacts are found they are either smoothed with files or emery paper, or the defective parts replaced.

Two general types of starting compensators, manual and magnetic, are used in electrically-operated stations. The manual starters are of two sizes, one for use on motors up to 250 hp. and carrying more than 2200 volts. One well-known make of compensators designed for high-voltage operation has a small control-circuit transformer mounted within the enclosure. The temperature overload relay, instead of being situated behind the steel panel, is mounted on the front of the panel and is reset by means of its own reset button. Both the manual and magnetic starting compensators are provided with conduit boxes, and the high-voltage, oil-immersed switches have barriers between the poles. An important feature of the construction of these high-voltage starters is the mounting of the oil switch behind a steel panel, in this manner affording extra protection against short circuits. In addition, both high and low-voltage starters are provided with time-delay undervoltage protection by a magnetic time undervoltage device.

The magnetic starting compensators also are designed in two sizes, carrying the same loads and with the same voltage ratings as the manual starters. The contacts are oil-immersed, each pole being housed in an individual compartment. The

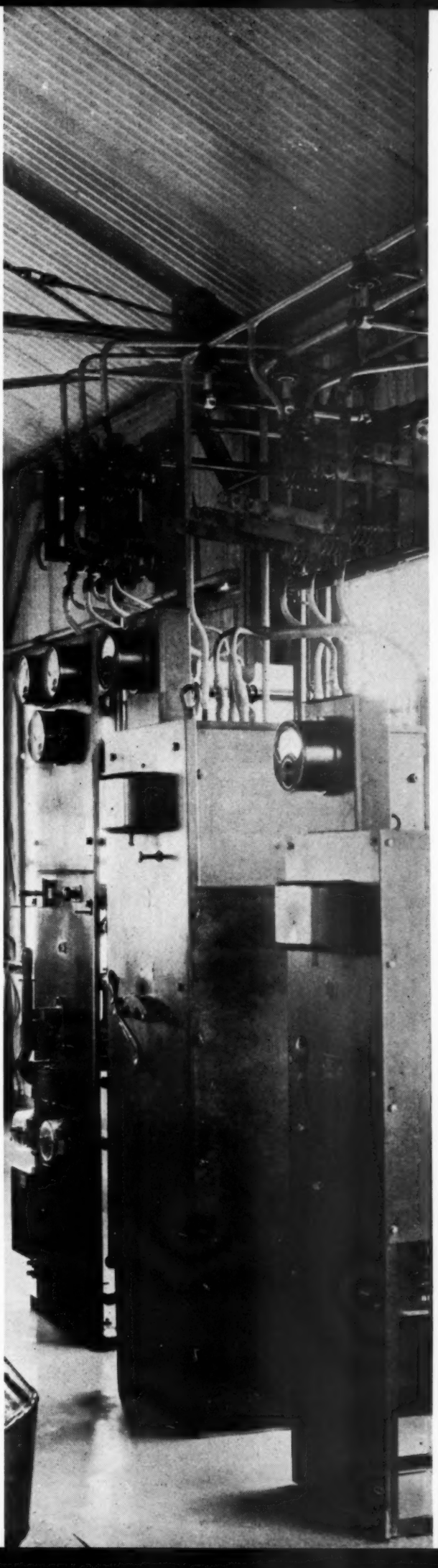
contactors are latched-in and are operated by a-c. solenoids. The sides and back of the framework housing the operating parts are removable, making all readily accessible for inspection.

Since most transformers operate with the coils immersed in oil, pipe line companies owning large numbers of transformers usually have appreciable quantities of transformer oil that require periodical changing or reconditioning. The type of equipment suitable for reconditioning this oil also may be employed for reconditioning the oil used in oil switches, and oil current breakers, although the quantity required for such purposes usually is small. Oil containing deposits of solid material, or having low dielectric strength, is unfit for use. Regular tests should be made to determine the dielectric strength and when it tests 16,500 volts or slightly above in standard transil oil testing equipment it should be reconditioned, or replaced with new oil. The standard spark gap for this test consists of two flat electrodes one in. in diameter spaced 0.1 in. apart.

Two methods for reconditioning transil oil are in common use: filtering, and purifying by centrifugal action. Special equipment has been devised for each. Since the filter press is best adapted to the handling of small quantities of oil, and most stations do not have excessive volumes to recondition, the filtering process is the one most commonly employed. The filter press is mounted on a "tip truck" and is provided with a pump, air bell, motor, piping, drip pan, and other auxiliary equipment. The essential portion of the press consists of a series of alternate flat cast-iron plates and frames between which the filter paper is placed and the whole clamped together tightly by means of a large screw and lever. The plate's surface is corrugated vertically and horizontally on both sides, effecting a checkered surface that supports the paper and forms channels connecting with the outlet at the corner of the plate. The oil centers at the lower left-hand corner of the stationary end of the filter, passes through a series of holes in the plates and frames and punched holes in the filter paper, and enters and fills in the chambers formed by the frames. It then passes through the filter paper, along the grooves of the checkered surface, to the lower right-hand corner of the plate, and thence through a series of small holes drilled from the surface of each plate to a cored passageway similar to the inlet. A rotary type positive-pressure pump is employed to force the oil through the filter press.

Usually one treatment with the filter press method is sufficient to produce a dielectric strength of 28,000 volts, considered of sufficient purity for all practical purposes. The best oil temperature for filtering is between 25 and 75 deg. centigrade. Below 25 deg. cent. the viscosity increases rapidly, while at 100 deg. cent. the process fails to remove water. If the oil to be reconditioned contains a large amount of water it should be allowed to settle and as much of the water as possible drained from the bottom of the container. Filter paper should be thoroughly dried in the oven provided for that purpose, and if not to be used immediately, stored under dry oil.

Where large quantities of transil oil are to be reconditioned a centrifugal purifier is frequently used. With this method the oil is forced through a bowl rotating at high speed and solid matter and water are removed from the oil by centrifugal action. Periodically this foreign material must be cleaned from the bowl. Centrifugal purifiers are operated in several ways, depending upon the condition of the oil and the type of apparatus in which it is used. The purifier is operated with a water seal that discharges both oil and water



Incoming line panel and hand-starting compensators in Magnolia Pipe Line Company's Midland, Texas, station

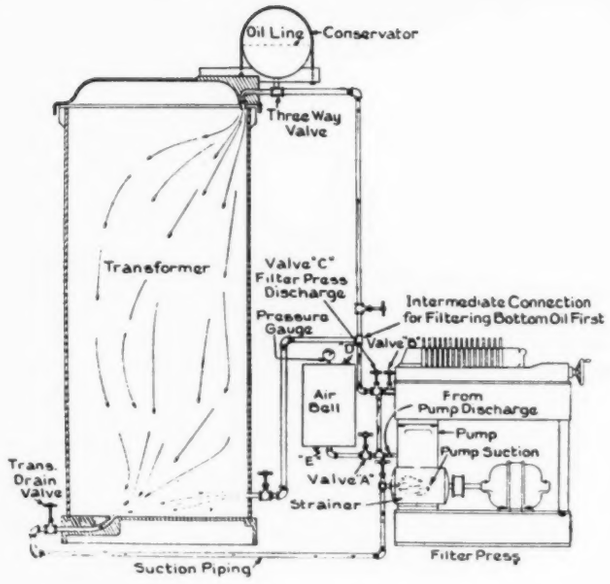


Diagram showing piping between filter press, air bell and transformer

when the oil originally contained large quantities of water; but when it is relatively dry the water seal is not used and only dry oil is discharged, the water remaining in the bowl.

Following inspection of the circuit breakers and compensators, in connection with which the reconditioning of transil oil has been discussed, switchboard panels are examined thoroughly. Inspection is for loose contacts, relay settings, a check-up of recording charts, and other instruments. It also is necessary that the complete lighting system, not only that of the station building, but also that used in connection with the storage tanks and for flood lighting, be checked regularly for loose contacts, broken switches, etc.

Each station is provided with overpressure relay protection so that the main feeder circuit breakers are tripped whenever excess pressures appear on the line due to closed gate valves, accumulations in the line, etc., and this equipment is examined monthly.

Bearing oil should be changed often, but while it might seem that no harm could come from changing it every few days if desired, there are those who oppose this view, holding that too frequent oiling of bearings may result in harm since the oil reservoir is easily run over during the process and, when that occurs, the excess oil is taken by suction into the windings of the motor, where it causes a stickiness that results in dirt and lint collecting. Proper ventilation to the motor is prevented, causing overheating, which dries out the insulation, making it brittle, and eventually resulting in a breakdown. Naturally the oftener bearings are oiled the more opportunities there are for this to occur. Also, the oftener oiling is done the more chances there are for grit to reach the bearings. Those who hold to this view favor changing bearing oil every three to six months. On the other hand, some companies have their operators change it monthly. As the quantity of oil used for bearing lubrication is small no attempt is made to recondition it.

This general schedule of inspection is supplemented by a less frequent one of certain of the station's equipment. Under this classification comes the overhauling of the motors, inspections of bearings, transformers and all high-tension wiring. Here again pipe line officials differ as to the frequency of this inspection. Some companies have it done semi-annually and others annually.

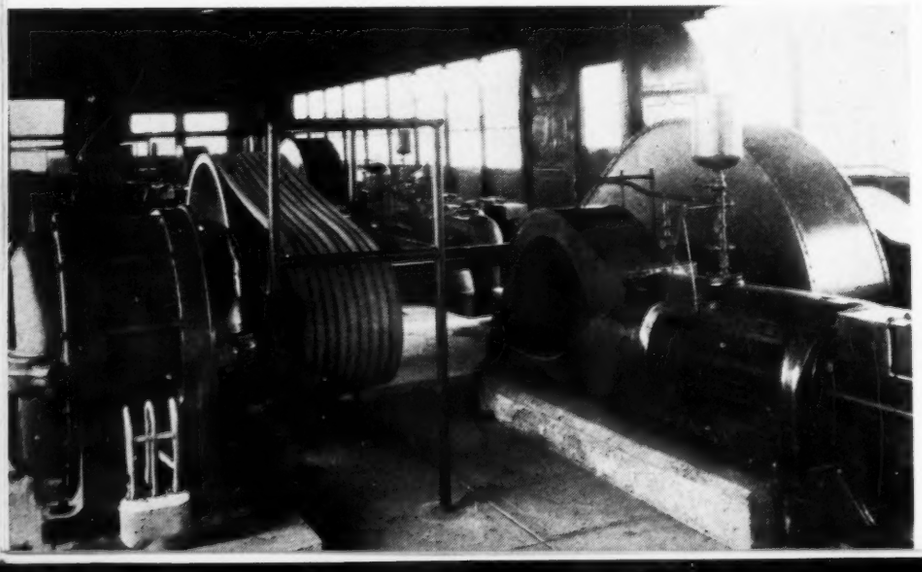
Motors require a minimum of maintenance. Some have been known to operate for as long as 20 years with no maintenance whatever; however, in general, if periodic inspections are given and certain perodic maintenance done the life of a motor can be prolonged indefinitely. Certain companies do this semi-annually, while others feel that if it is done annually, adequate results are obtained. Whatever the period determined upon, the motor should be dismantled and both the rotor and the stator, including the coils, thoroughly cleaned. A recommended cleaning fluid is carbon tetrachloride. Gasoline would serve as a cleaning fluid, but is not recommended because of the danger of explosion. Following this cleaning the coils should be inspected for damage to insulation, and when thoroughly dry, a coat of air-drying insulating varnish applied. In instances where the motor has been in service for a long period of time without this work being done two coats of varnish are necessary.

Bearings should be checked for wear and smoothness, as should the journals. The motor is then reassembled, making certain that clearance on both bearings is approximately equal. Care also should be taken that this clearance is not excessive. If found necessary, the complete motor frame should be painted.

As a rule power transformers at pipe line stations are furnished and maintained by the power company. However, during the time elapsed since the previous inspection, lighting and low-voltage power transformers, as well as certain flood lights or small motors, might have been added to the transformer load and it is well as a part of this inspection schedule to make a check to determine if an overload condition exists.

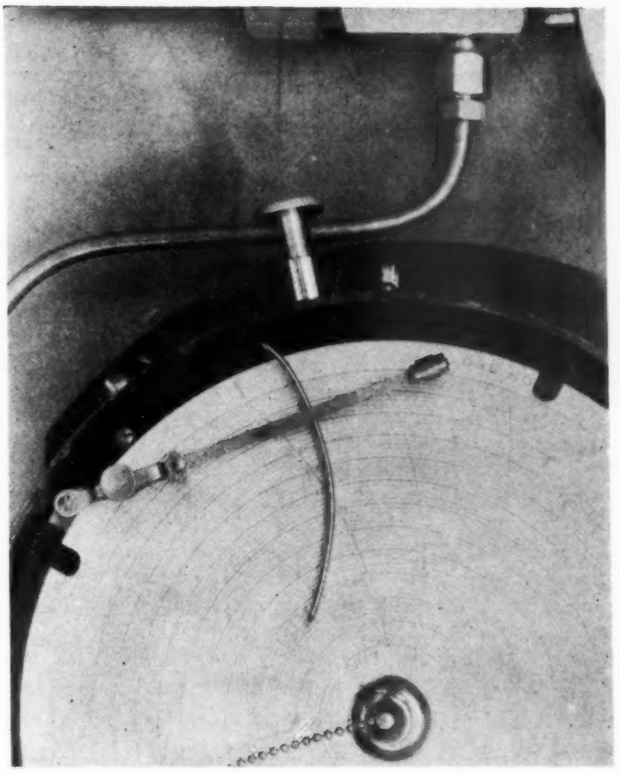
As a final step in the program all high-tension wiring should be examined, necessary repairs made, and flame-resisting paint applied.

During recent years when many stations have been shut down a considerable portion of the time as a result of curtailed crude oil production and curtailed consumption, it has been found advantageous by many companies to carry out the same maintenance program in respect to non-operating stations as for those pumping oil daily. Where this has been done and, in addition, the former put into operation at least once each month for a period of approximately 15 minutes to prevent the shafts from corroding, equipment has been maintained on a high plane of efficiency throughout the system.



Electric motors driving reciprocating pumps in main line station of West Texas pipe line

By means of the control pin the clock is started and stopped whenever desired.



By
WALLACE A. SAWDON
Petroleum Engineer,
Los Angeles, California

Pressure-Time Chart Taken During Cementing Provides Valuable Well Record

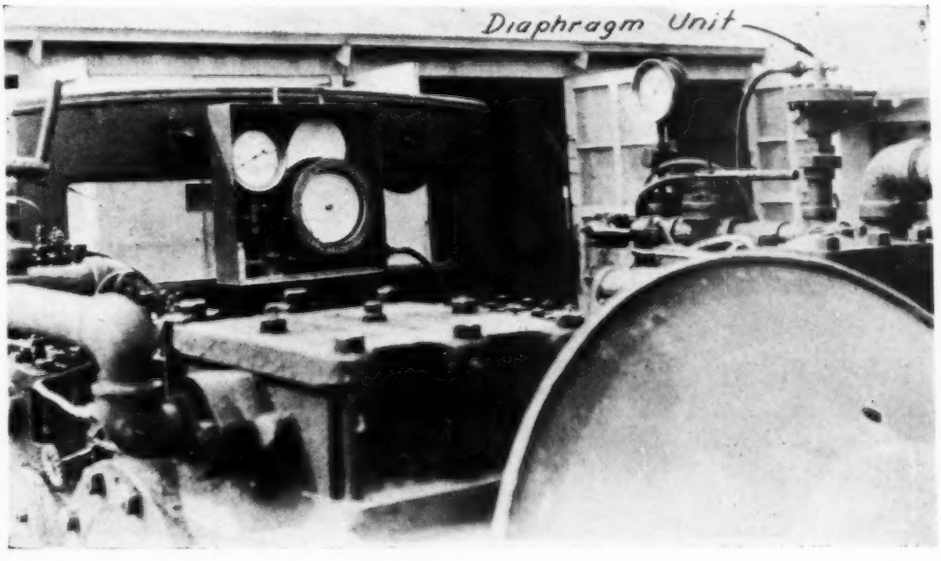
THERE is a tenseness connected with a cementing job that has a natural tendency to prevent proper attention being paid to the pressures and time involved in the operation. Yet the time that elapses during cementing and the pressures used to put the cement in place have a definite bearing on the success of the job. Moreover, a permanent record of these will often be found of value in planning future repair work. Operators in California have recognized these facts and, in response to their desire for a permanent, automatic record of time and pressure, there has been developed a recording pressure gauge particularly adapted to this work.

The importance of such a pressure chart of cementing jobs is reflected by the check it gives on the operation. The mixing time is clearly indicated and the time it takes to pump the cement is recorded with the pressure that is applied at every moment. The record is automatic and the final pressure is always known.

Any accidents that may occur will show up on the chart as will also the time (with reference to the time of starting) that they occur. How long the operation is shut down and what the pressure was before, during, and after a shut down are also factors of interest and importance.

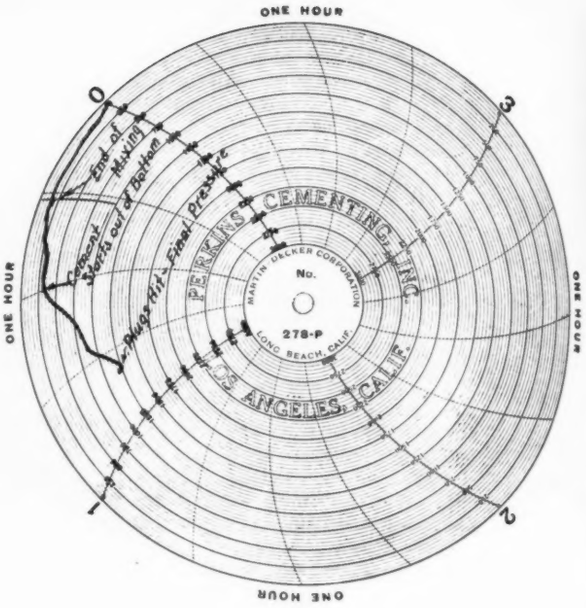
When the cement is preceded by water a record can be obtained of the time taken in pumping it down and what pressure was used. Also, by connecting to the circulating pumps, information relative to the time of circulation and pressures used during that time may be procured with the cementing recording gauge. Cementing outfits are, of course, frequently used to break circulation, and in the past few months a number of interesting charts of this operation have been recorded.

While the recording pressure charts may appear to be a check on the cementing company's operation, the record they furnish the operator eliminates any cause for misunderstanding. Of greater value, however, is the story they tell about the cementing operation. When the time-pressure record is studied in connection with other well data, the prospects



When mounted in a case on the cab of the cementing truck, the recording pressure gauge is protected from any vibration by the complete spring hanging

An example of the pressure record made in cementing a string of casing in a California well



of success can be fairly well determined. Such well data as the size of casing, length of string and number of sacks of cement used are entered on the back of the chart. In making the study, these should be considered with the condition of the hole preparatory to cementing, the gas, oil or water pressure, and the characteristics of the formations.

The pressure chart becomes a definite part of the well history and will prove valuable in planning repair work. Problems more difficult of solution than those encountered in the first cementing of a string of casing usually accompany re-cementing and repair jobs. Every bit of information regarding the subsurface conditions should be known. Production records often show the cause of the trouble and the drilling records should help disclose the condition of the hole. Geological data will help point out the causes and location of the trouble.

It can readily be seen, therefore, that when re-cementing or repair work involves an old cement job, data on the time and pressure necessary to place a certain number of sacks of cement around a certain size string at a certain depth will often aid in planning the operation. During the repair work itself, a record of the time and pressure should be made.

The Pressure-Time Recorder

The instrument being used for recording the pressure and time in cementing operations was developed by Martin-Decker Corporation. It consists of a recorder and indicating gauge protected by a special pulsation damper connected by ¼-in. O.D. flexible tubing to a diaphragm placed on the manifold of the cementing pump. When gauges are mounted directly on the pump there is too much pulsation to give even a fair indication of the pressure, and the fluid itself quickly renders gauges useless.

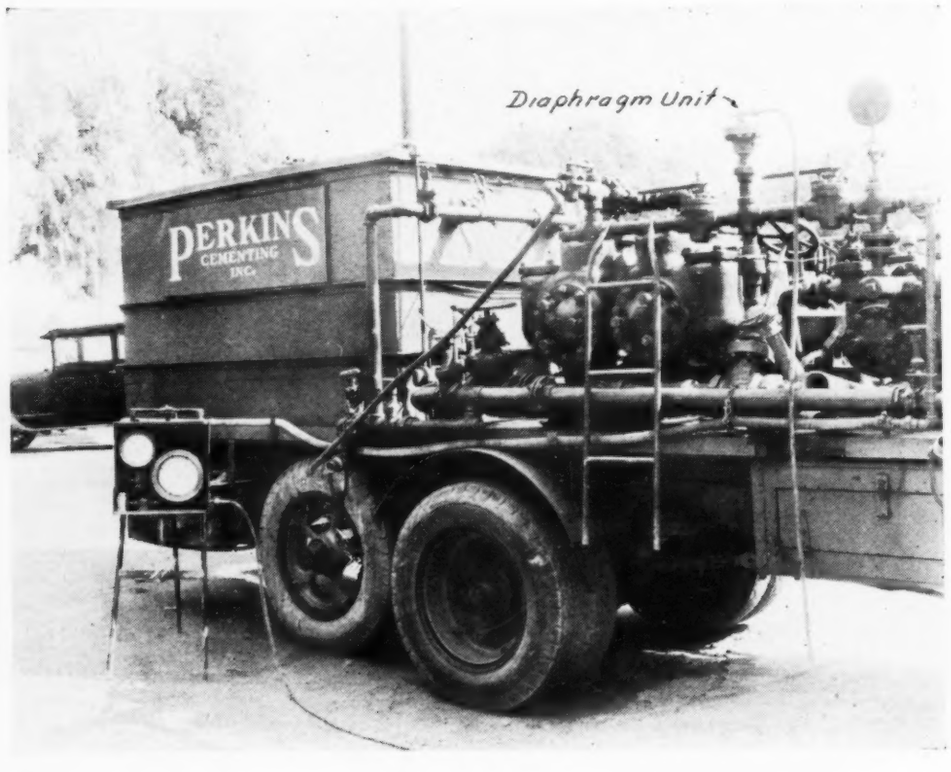
The recorder is operated by a four-hour clock, which covers a time in excess of that required by any cementing job. It is fast enough, however, to extend the record of the operation over a chart distance that will show every change in pressure with great legibility. The clock is started and stopped by a control pin.

The recorder and indicating gauge are mounted in a case that is placed either on the back of the truck cab or on a tripod on the ground. When mounted on the cab, the case is supported by a bar at the top that is hung on springs. The bottom of the case is connected to the cab by two springs, one in compression holding the case from the cab and another in tension pulling it toward the cab. In this way vibration is eliminated and an accurate record of the pressure is obtained.

When two outfits are used for the cementing job, the gauge case is supported by a tripod on the ground. By this arrangement, the recorder can be changed from one to the other without loss of continuity in the record.

The recorder generally used is for pressures up to 3000 lb. per sq. inch. There are special types for pressures up to 5000 lb., since in some cases pressures in excess of 3000 lb. are necessary, especially when the pumps are used on a job where it is difficult to break circulation.

The diaphragm unit placed on the pump manifold contains a flexible, oil-resistant diaphragm totally enclosed. The system from it to the gauges is filled with clear fluid. In order



Here is shown the recording-pressure gauge mounted on a tripod placed on the ground. This mounting is generally used when two cementing outfits are used

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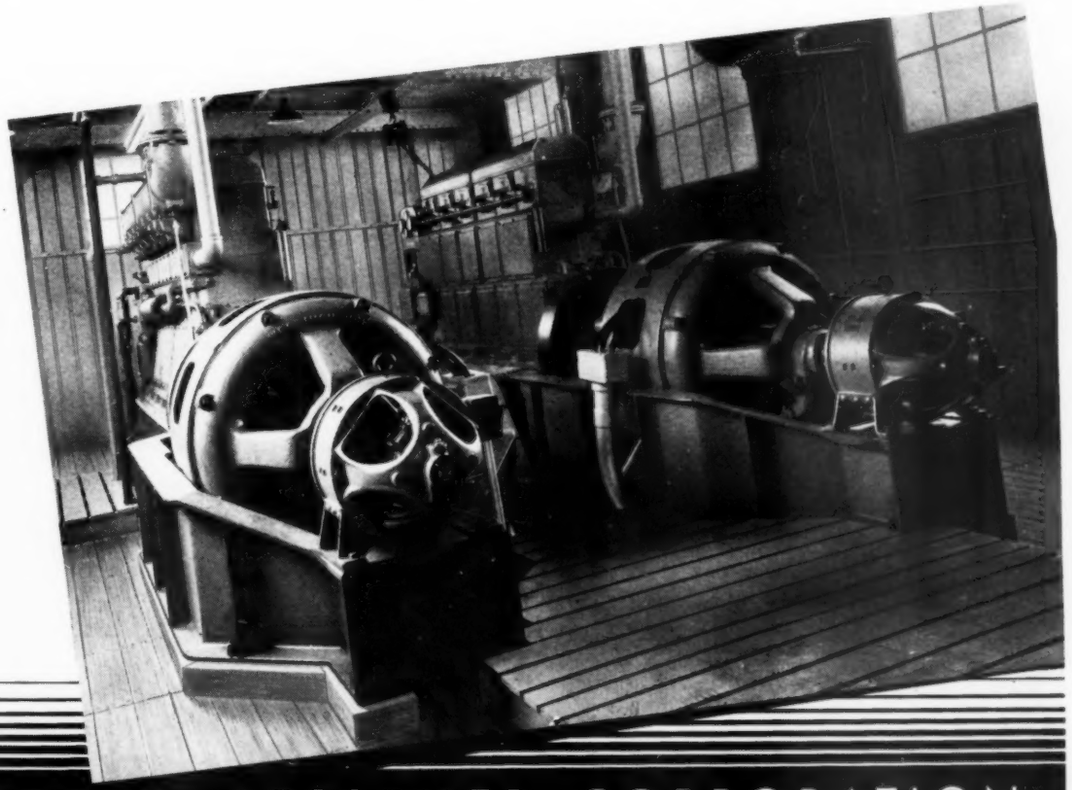

14 WELLS have been drilled at low cost by the twin power plant illustrated. Dependable power for the draw works, rotary table, and mud pumps is supplied economically by two Type FP-6 Cooper-Bessemer Diesel engines rated 242 H. P. each at 514 r. p. m. and direct-connected to two 219 K. V. A. generators.

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to eliminate pulsations and inertia effects caused by pump valve and piston action, a pulsation damper, also manufactured by Martin-Decker Corporation, is attached to the gauge connections. This provides an even line on the chart without affecting the sensitivity of the gauge.

Operation

The record chart is divided into 16 quarter-hour periods with the hours indicated from zero to four. When the job is about to commence, the pen is set at zero, and when the mixing of the cement begins the clock is started by pushing the control pin in. As soon as the mixing is finished and the cement starts down the hole, a line is usually made on the chart by moving the pen toward the center. In this way the time devoted to mixing is definitely indicated.

During the entire operation, both the beginning and end of any delays should be similarly marked. The time of shutdown caused by changing heads, by accidents or by any causes whatever will thus be recorded. When trouble occurs in the midst of a cementing job, the time consumed seems to be much longer than it actually is. The record shows just how long operations were shut down.

The final pressure is always available on the pressure chart. The gauge never forgets to register it and there is no question about the accuracy of the reading. During the cementing operation, everything is so precisely timed and the men are so intent on the placing of the cement most effectively that there is every reason why attention to the gauges may be overlooked. Most of the operators in California now rely on the recorder, as there is no chance of contamination or stoppage by cement, and pump pulsations are completely smoothed out.

Flow Line Dehydrator Treats Cut Oil at the Well

HERE is a diagrammatic sketch of an electric dehydrator installed at Signal Hill, California. This is the first one to operate successfully in California as a flow line treater, dehydrating the oil as it is pumped from the well without preheating.

The dehydrator is on a lease that produces 400 bbl. gross oil daily, all of which comes from a single well. The power for pumping this well is supplied by a small engine that operates on gas from the well. The dehydrator is installed directly alongside the derrick.

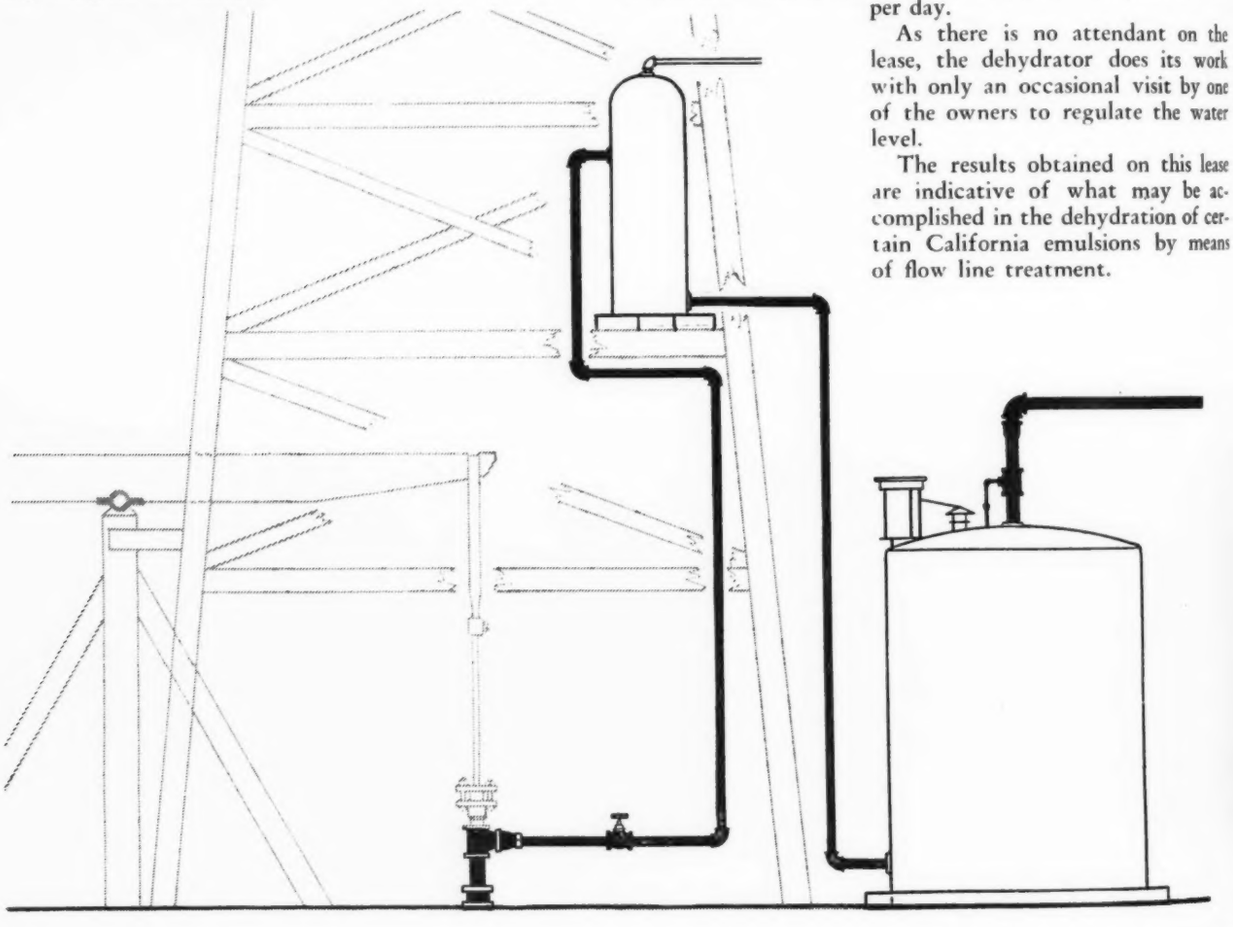
The oil is produced at a temperature of 120 deg. fahr., and cuts 61 per cent emulsion and 3 per cent water, or 64 per cent B.S. and water.

After leaving an elevated gas trap situated in the derrick the production flows through a lead line into the bottom of the dehydrator. From the top of the dehydrator, the treated oil cutting 0.6 per cent flows to the shipping tank without additional pumping.

The treated oil has a gravity of 25.5 deg. A.P.I. at 60 deg. fahrenheit. Current consumption is approximately 24 kw-hr. per day.

As there is no attendant on the lease, the dehydrator does its work with only an occasional visit by one of the owners to regulate the water level.

The results obtained on this lease are indicative of what may be accomplished in the dehydration of certain California emulsions by means of flow line treatment.



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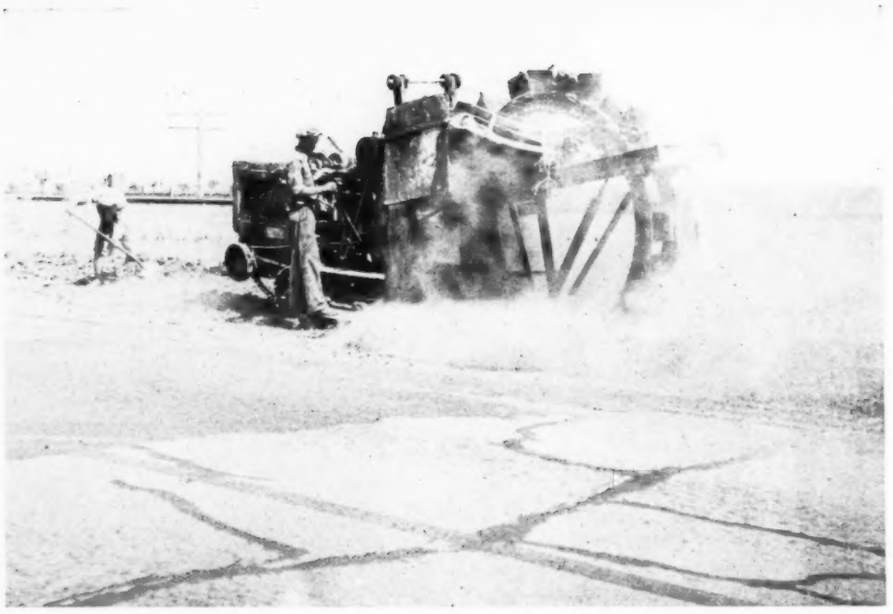
DERRICKS SUBSTRUCTURES HANGERS WALKING BEAMS SAMSON POSTS JACK POSTS BULL AND CALF WHEEL POSTS
WHEELS PITMANS IMPROVED BEARINGS CROWN BLOCKS PORTABLE PUMPING UNITS CLEAN-OUT MACHINES WINCHES



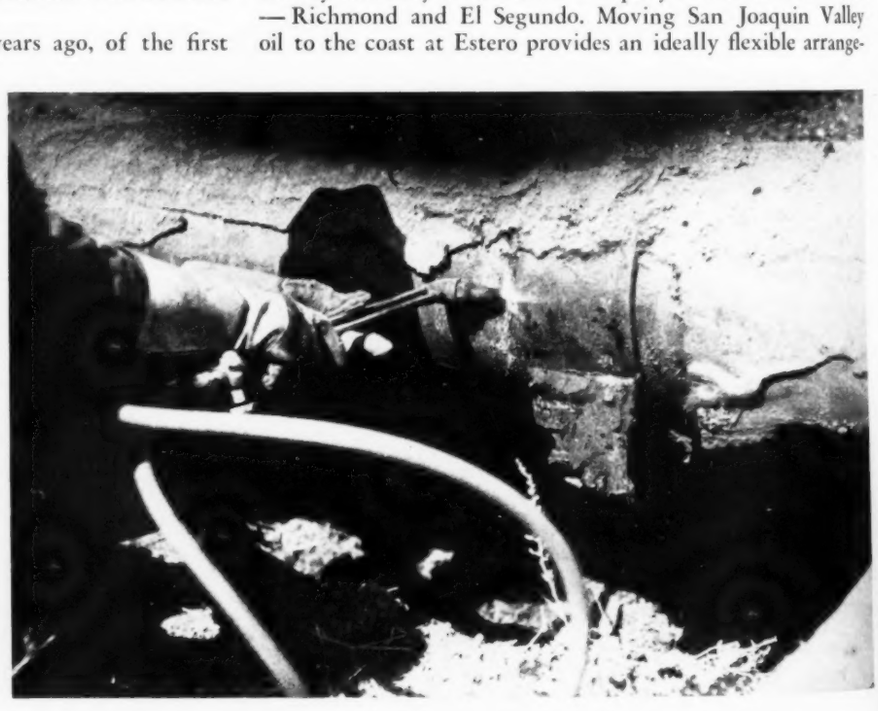
Perhaps 80 per cent of the pipe to be laid in the new 108-mile pipe line of the Standard Oil Company of California will be reclaimed from the present Bakersfield-to-Richmond line. Some of the more important tasks involved in taking up this pipe and preparing it for its new use are pictured here and in other photographs accompanying this article. The first step, of course, is uncovering the pipe with a ditching machine

A New Outlet for San Joaquin Oil*

EARLY next spring, with the completion of the important pipe line project now under way, the Standard Oil Company of California's marine loading terminal at Estero Bay, on the California coast a few miles north of San Luis Obispo, will become one of the busiest oil shipping points on the Pacific Coast — if not in the world. For then the quantity of oil at present passing through this terminal will be more than doubled.

Since the installation, almost five years ago, of the first pipe line from the Kettleman Hills field to salt water, the efficiency and economy of handling oil through the Estero terminal have been amply demonstrated. It is doubtful if there is any other terminal in the world where tankers can be loaded so rapidly and so economically. For here gravity takes the place of pumps; here there is no operating cost beyond the opening of a valve in the pipe line that leads from the tanks on the high hills above the beach out along the bottom of the bay to the tanker station, about 3000 ft. offshore. In addition to its economical operating features, Estero has the advantage of being almost exactly half-way between the company's two main refineries — Richmond and El Segundo. Moving San Joaquin Valley oil to the coast at Estero provides an ideally flexible arrange-

*From *Standard Oil Bulletin*, Standard Oil Company of California.



When the pipe is removed from the ground, welders with torches cut off each alternate collar, leaving two 20-ft. lengths of pipe still threaded together. These are hauled by trucks to the reclaiming plant, where the other collars are removed, the dirt and corrosion burned off in a furnace, and the threads cut off by a machine that leaves the pipe with beveled ends for later welding

Here the sand-blasted pipe is laid out and welded into 40-ft. sections for economical handling by the trucks and to reduce the number of welds necessary in the field. The "loops" of the old line, whence came the pipe, were joined by threads and collars. The new line will be electrically welded throughout

ment for delivering any quantity of any grade to either refinery.

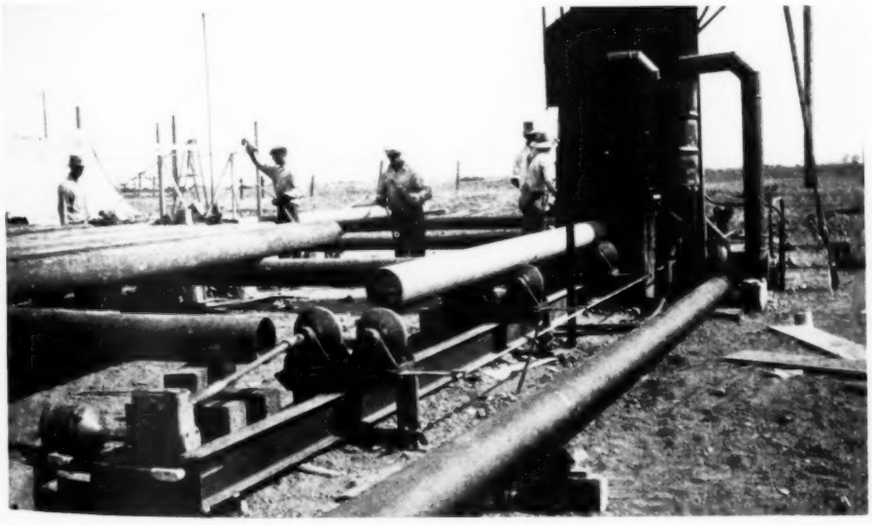
Because of the successful and low-cost handling of Kettleman crude through this terminal, it was natural that the company should consider ways and means of providing transport overland for other of its San Joaquin Valley production. The result of this planning is the new line on which construction was recently started, a line that will cost some $4,000,000, and will connect the oil fields in the south end of the San Joaquin Valley with the Estero terminal. It will consist of 108 miles of 12-in. pipe, starting at the company's present Rio Bravo pump station in Kern County, running to a junction with the present Kettleman Hills-Estero line at a point in the Cholame Valley, and thence following the present right-of-way to Estero Bay. The entire line will be electrically welded, and where it traverses corrosive soil the pipe will be treated with Somastic, the scientific protective coating developed by the Standard Oil Company of California, and proved by nation-wide tests under the auspices of the U. S. Bureau of Standards to be unsurpassed in resisting attack by the most corrosive soils in the country.

A glance at the accompanying map will show how directly this line will convey oil from the Kern River and Midway fields to the centrally located marine loading point. When completed, the line will be not only the largest but the most modern and most economical oil pipe line in California. Most of the pipe to be used is now being reclaimed from the 12-in. "loops" that were added to the Bakersfield-to-Richmond line during the period of peak valley production. But to carry the high pressures that will be applied to the oil at the pumping stations, new heavy high-strength seamless pipe is being purchased for the first few miles of line out of each station, where the pressure is greatest.

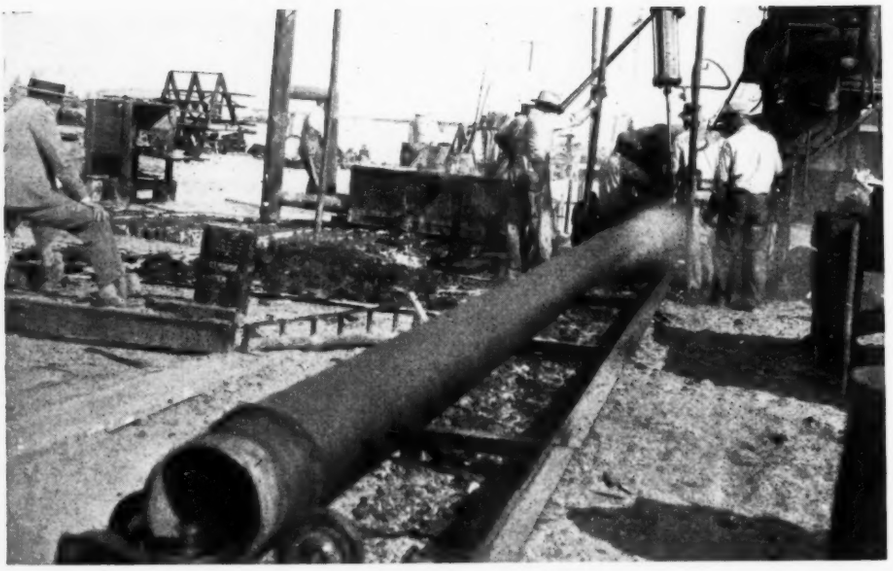
A considerable portion of the oil that will move through the new channel is the heavy viscous crude produced in the Kern River district. In order to pump this oil economically, it must be maintained at a high temperature, which means that combined pumping and heating stations must be located at fairly frequent intervals along the line. As indicated on the map, it is planned at present to install five of these stations, about 18 miles apart; existing facilities of the Rio Bravo and Kern River stations will be revamped. At each unit arrangements will be made to pass the heavy oil through heaters into which exhaust steam from the pump is discharged. With this plan the maximum benefit is derived from every pound of steam used — the pressure energy is utilized first in the pump, then the heat energy is put to work in the heaters. The heaviest oil will be heated to a maximum temperature of about 180 degrees.

This system will be designed to handle as much as 50,000 bbl. a day of this heavy oil, and up to 70,000 bbl. a day of lighter oil. The heavy oil will move through existing gathering lines from the Kern River field to Rio Bravo station, there to be pushed through the new line to the coast. Rio Bravo station will also serve as a gathering point for the lighter oils produced in the Midway, Elk Hills, and other west side fields. Since these different grades of oil must be delivered separately to Estero, "batches" of the various grades must be accumulated at Rio Bravo. For this purpose steel tankage to hold some 700,000 bbl. is to be constructed at that station. These tanks will all be equipped with the modern type of floating roof, which minimizes evaporation losses and greatly reduces the fire hazard. Other steel tanks to accommodate several hundred thousand bbl. of oil will be required at the Estero end of the line, to hold the different grades in readiness for loading.

A new submarine line will be laid along the ocean floor, diverging sufficiently from the present line so that their ends will be far enough apart to permit two tankers to load simultaneously. Thus it is seen that, although part of the



The bevel-ended pipe lengths are shown going through the sand-blasting machine, which cleans them down to the bare metal. If there are pits in the surface they are then filled by spot-welding and the 20-ft. lengths are welded into 40-ft. sections, ready for delivery to the field or, if to be treated with Somastic, to the coating machine



Where surveys show that the new line will be laid in corrosive soil, special treatment is given the pipe for such portions. The lengths are run through the machine shown here, emerging with a complete protective coating of Somastic

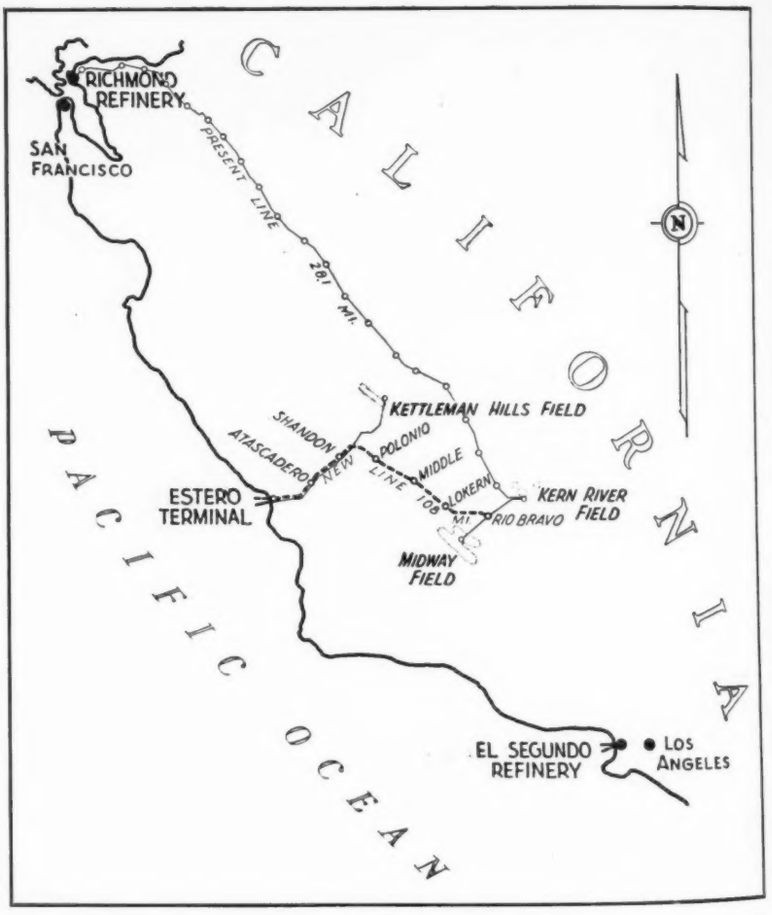
same right-of-way is used, and the terminal site is the same, there will be two completely independent pipe line systems, two groups of tanks, and two separate submarine lines.

Owing to the heavy viscous nature of some of the oils to be handled, it has been decided to make the new submarine line even larger than the present 16-in.-diameter one. It will be, therefore, 18 in. in diameter, and since it must be heavy enough to submerge when filled with air during the launching process, the walls will be $\frac{5}{8}$ in. thick. This will be the largest and heaviest submarine line ever laid, and it presents a number of interesting construction problems — to the engineer rather than to the general reader. The pipe extending from the tanks down to the point where the submarine line enters the water will be 22 in. in diameter.

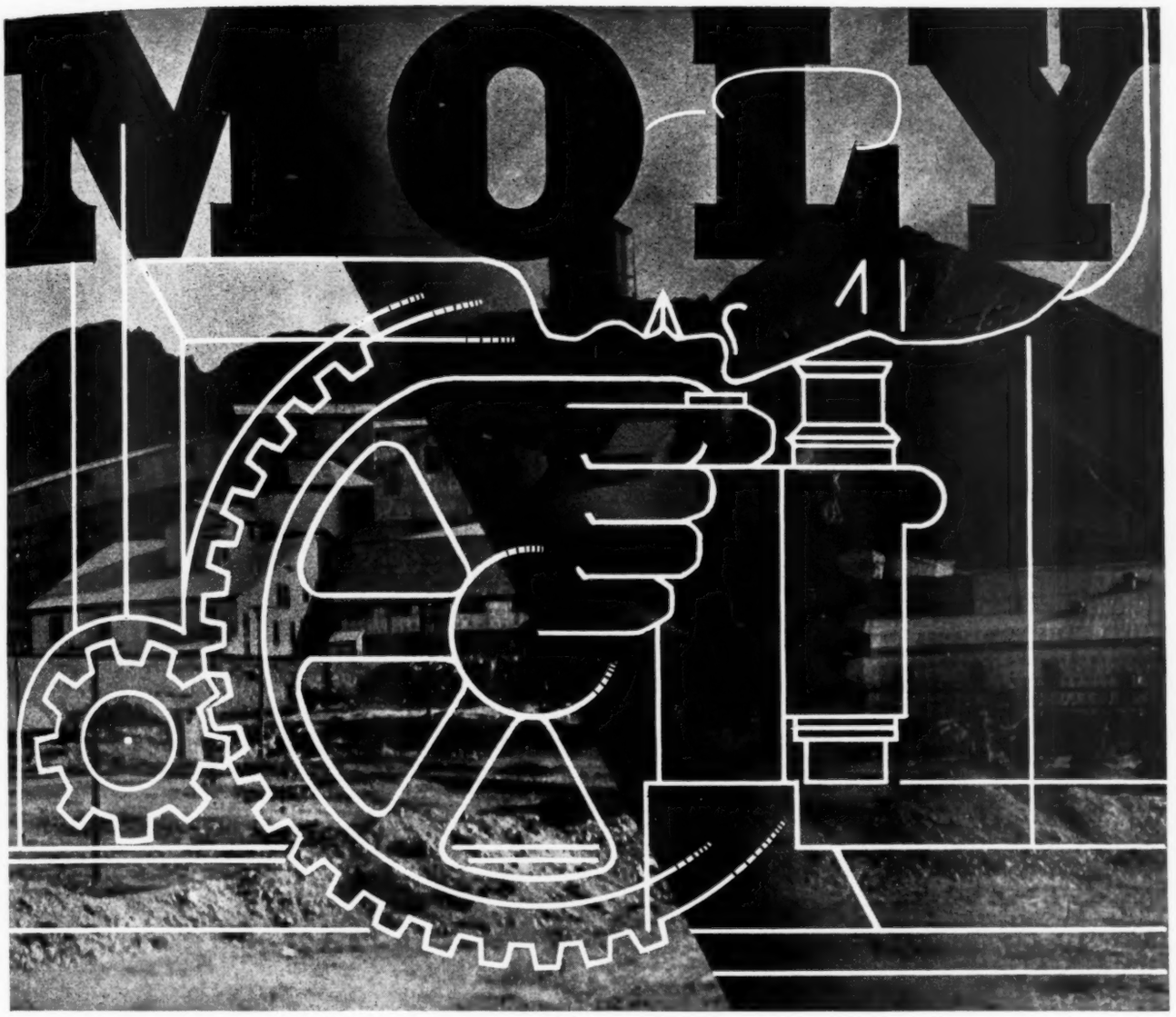
The methods of installing and operating submarine loading lines have been described in previous issues of the *Bulletin*, but in response to numerous inquiries certain features of the loading procedure are detailed here. To aid in this exposition, a diagrammatic sketch is presented. As indicated in the three scenes of the sketch, a large hose about 200 ft. long is permanently connected to the seaward end of the submarine line — about 3000 ft. from shore in some 50 ft. of water, depth enough safely to accommodate the largest tankers. When no ship is loading, the hose rests on the bottom, with a chain running up to a buoy on the surface. After a tanker has anchored in the mooring berth, the ship's tackle is attached to the buoy and the submarine hose is hoisted. Aboard ship a length of special deck hose is attached to the inlet connection of the vessel's piping system. The other end of this deck hose projects beyond the deck, and is provided with an elbow looking down toward the water. When the end of the submarine hose has been hoisted to the level of the deck, the crew removes the blind flange with which its end is sealed when not in use, and bolts the hose securely to the elbow of the deck hose. Valves are then properly set in the ship's piping system to deliver the oil into the desired tanks, and a signal is given the shore-side crew that all is in readiness.

A submarine telephone cable extends alongside the pipe line out to the mooring berth, where a small buoy marks its end. This is lifted aboard ship and connected to a specially designed telephone, providing direct communication between the ship and the control house on shore. To supplement this, a system of whistle signals is also used to make doubly certain that there is no misunderstanding, and as an extra safeguard against the possible contamination of the harbor water.

As previously mentioned, the storage tanks at the Estero terminal are high above sea level. The hills rise to about 700 ft.; the present pipe line running from the tanks to the edge of the water is 20 in. in diameter; and the submarine line



As will be seen on this map, the Estero terminal is practically half-way between the Standard's two main refineries, Richmond and El Segundo, which makes the movement of San Joaquin Valley crude to the coast by pipe line and thence by tankers an economical and efficient procedure. The routes of the two present lines and the new line are indicated, and along the latter are shown the proposed pumping stations, which also will be equipped to heat the heavy Kern River oil as it flows to the marine terminal



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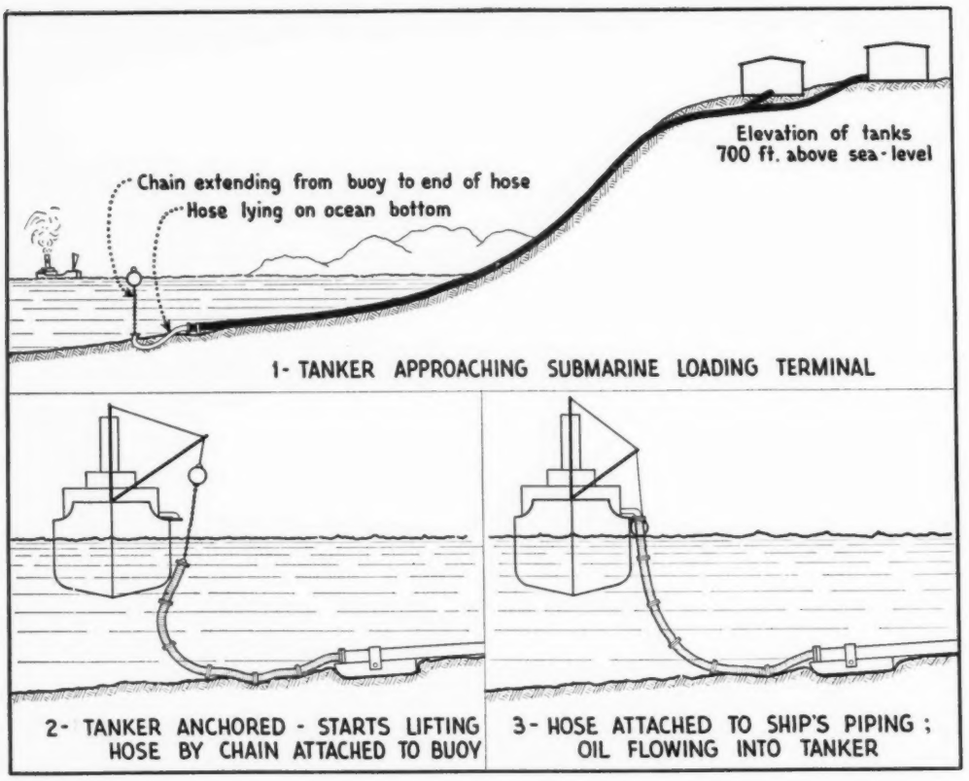

Elevation of tanks
700 ft. above sea-level
Chain extending from buoy to end of hose
Hose lying on ocean bottom
1- TANKER APPROACHING SUBMARINE LOADING TERMINAL
2- TANKER ANCHORED - STARTS LIFTING HOSE BY CHAIN ATTACHED TO BUOY
3- HOSE ATTACHED TO SHIP'S PIPING ; OIL FLOWING INTO TANKER

These sketches, purposely drawn in exaggerated scale, show how a tank-ship is loaded at the Estero marine terminal, where the oil flows aboard by gravity. Although not indicated, the vessel is securely moored to five huge anchors before the hose is connected up

measures 16 inches. With this large pipe and the 700-ft. drop, oil flows into the ships' tanks at a very rapid rate — up to 15,000 bbl. an hour, the exact rate depending on the grade of oil, the temperature, and other factors. At these high rates even the largest tankers are loaded in ten hours or less. The new line, with its larger pipe, will deliver the most viscous oils that it will handle at substantially the same high rates.

Those cargoes of oil that go by tank-ship from the Estero terminal to El Segundo refinery are received at that refinery through two submarine lines, one of which was recently laid. At Richmond additional facilities will be required in order to receive from tankers oil that previously came through the Bakersfield-to-Richmond pipe line. The exact type of equipment to be installed for this purpose has not yet been definitely determined.

Altogether, this new project is one of the largest construction jobs undertaken by the Standard Oil Company of California in recent years. When it is completed this important addition to the company's facilities in California will yield an attractive return on the necessary investment, owing to the economies made possible by the use of a much shorter pipe line pumping from Rio Bravo to Estero — 108 miles as compared with 281 miles from Bakersfield to Richmond — the efficient gravity-flow marine-loading terminal at Estero, and the flexible movement of oil to either refinery from such a centrally located point. In the matter of cost, it has been proved that the transportation of oil by pipe line and tanker over this route is considerably cheaper than via the all-pipe-line route.

Construction of the new line at this time is a definite contribution to the industrial recovery program, for it will employ about 1000 workers and distribute vast sums for wages and materials. Approximately seven months will be required to complete the project and have it in full operation.

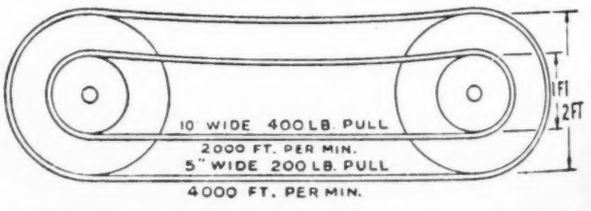
How to Save Belting

By W. F. SCHAPHORST

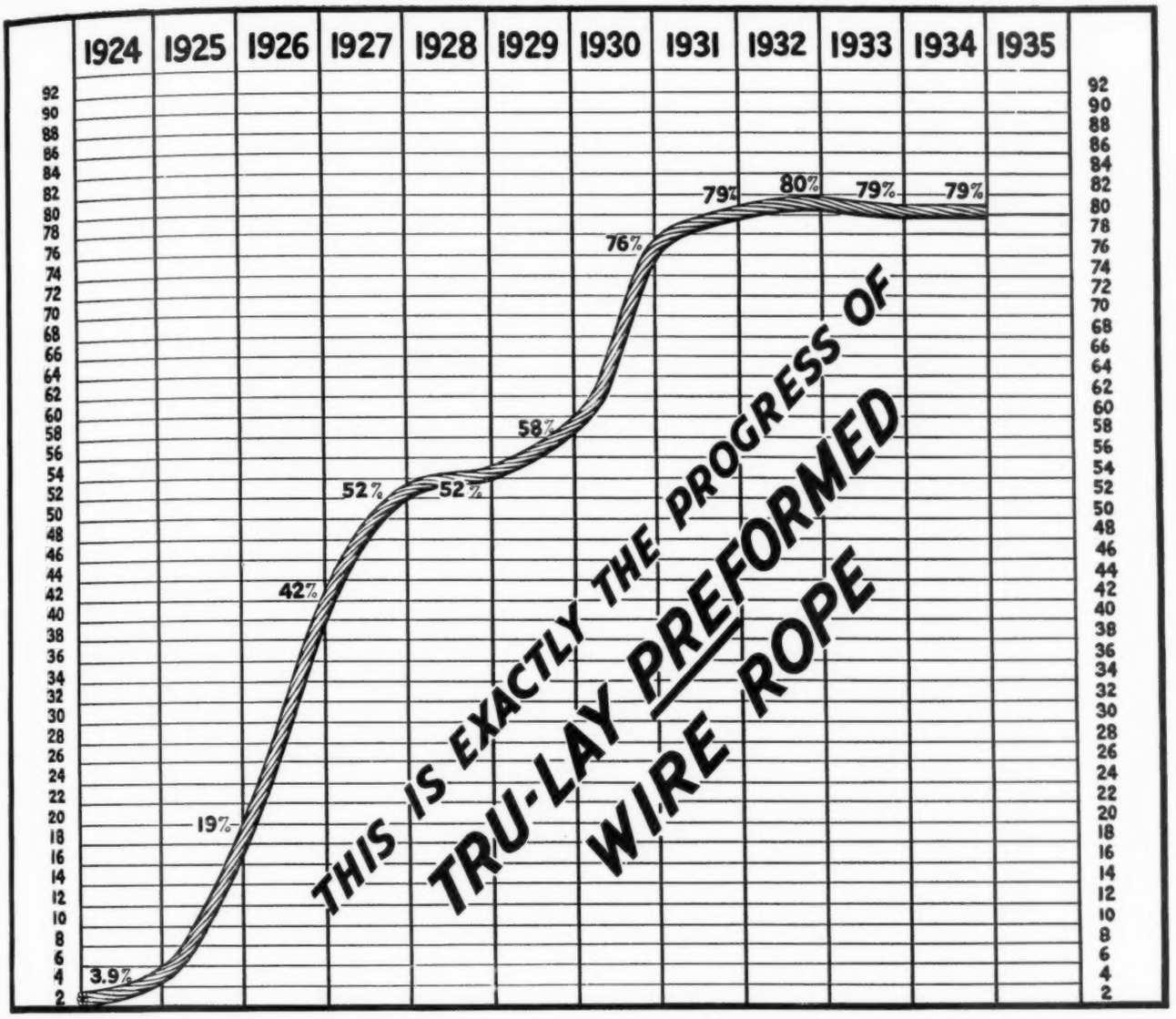
THE drawing herewith shows how to cut belting costs almost in half. It shows that the belt pull on the bearings is dependent entirely upon the diameter of the pulleys. The larger the pulley the better; the less pull.

Thus this drawing shows that if the pulley is one ft. in diameter, a 10-in. belt will be required at a speed of 2000 ft. per min. The belt pull on the bearings will be 400 pounds.

Now, in place of the small pulley let us substitute one twice as large—two ft. in diameter. A 5-in. belt will do the same work (and will do it better because the pulley is larger); the belt speed will be 4000 ft. per min. (not excessive), and the belt pull on the bearing will be only 200 pounds.



In addition to cutting belt costs power is saved by reducing the belt pull to the minimum.



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The Optimum Economic Design of Unfired Pressure Vessels Graphically Calculated in Accordance with the A.P.I.-A.S.M.E. Code

By

M. E. CLAWSON and T. O. DULLER

Continental Oil Co., Ponca City, Okla.

THIS paper introduces a set of 11 charts and nomographs covering the major parts of a pressure vessel, and based upon the A.P.I.-A.S.M.E. Code. The temperature tensile relationship is based upon 55,000-lb. carbon steel. Other steels may be used by direct ratio, subject to the requirement that if the stresses are calculated for metal temperatures above 700 deg. fahr., the basic stress if higher than 55,000 lb. ultimate, be that for the steel in its annealed condition. (See note under Fig. 1 of Code).

- The flexibility of the nomographs will become apparent after use. They are not intended to eliminate the use of the code but are intended as a supplement to it, when detail calculations are not required.
- Examples of their use are included and may be used for new or existing pressure vessels. Paragraph numbers of the code are given throughout the paper and on the charts for reference when more detail is desired.
- The original average accuracy of the nomographs, when properly used, is within five per cent, although reproduction has altered this somewhat.

EDITOR'S NOTE: Popular interest in this paper, which was read at the A.P.I. meeting held recently in Dallas, has prompted its publication at this time.

NOMENCLATURE

THE symbols used in this paper have the following meanings. They are as near the same as those used in the code as are possible without confliction:

c = Corrosion allowance in inches.
C = Factor for bolted flat cover plates with ring type gaskets $= 0.30 + \frac{1.4\ whg}{HD}$
d = Diameter of finished hole in nozzles in inches.
D = Mean gasket diameter of ring type gaskets in inches.
D_1 = Outside diameter in inches.
Dm = Mean major diameter in inches.
Dn = Mean minor axis of ellipsoidal heads in inches.

SUMMARY OF UNFIRED PRESSURE VESSELS
API-ASME REQUIREMENTS

SPECIFICATION	FUSION WELDED CONSTRUCTION	RIVETED CONSTRUCTION
DIAMETER	Limited to (P-15)(D-4)< 60 (W-100)	Limited to (P-15)(D-4)< 60 (R-100)
THICKNESS	Unlimited	Unlimited
PRESSURE	Unlimited	Unlimited
TEMPERATURE	1000°F Maximum (W-100)	1000°F Maximum (R-100)
MATERIAL	Unlimited Thickness: 1 ASTM A-70; 2 ASTM A-30; 3 ASTM A-149 (2" Max.); 4 ASTM A-150 (Over 2"-4" Max). Limited to 5/8" and/or 450°F: 1 ASTM A-7; 2 ASTM A-10; 3 ASTM A-113	Unlimited Thickness (R-201): 1 ASTM A-70; 2 ASTM A-30; 3 ASTM A-149. Limited to 5/8" and/or 450°F: 1 ASTM A-7; 2 ASTM A-10; 3 ASTM A-113
JOINT EFFICIENCY	Maximum 95% if Radiographed and Stress Relieved 80% Otherwise (W-320) (Double Weld Butt Joints)	To be Calculated (See Chart Nº 4) (R-320) (Appendix C)(Fig 25)
LONGITUDINAL JOINTS	Double Weld Butt - Unlimited Thickness; Single Weld W/Backing Up Strip Limited to 1 1/4" Plate; Single Weld Butt without Backing up Strip - Limited to 5/8" Plate. (W-320)	Lap or Single Butt Joint up to 5/8" Plate and/or 150#/in² and/or 200°F Double Strap Joint otherwise (R-320)
CIRCUMFERENTIAL JOINTS	Same as Longitudinal Joints-or Double Full-Fillet Lap-Limited to 5/8" Plate, Single Fillet Lap with Plug Welds Limited to 5/8" Plate (W-320)	Single riveted Lap up to 450°F and provided Joint Eff not less than 50% Longitudinal Joint (R-320)
STRESS RELIEF	Required When Diam. of Vessel in Inches + Thickness of Shell is less than 100 or When Plate Thickness is 1 1/4" or over - 1100°F/Hr/Inch Thick (W-318)	When Welds are present that require stress relieving. Relieving before riveting is done.
RADIOGRAPH	Required to Gain Maximum Joint Efficiency (See Above)(W-320)(W-318)(W-524)	Only when Welds are present and to gain maximum efficiency
HYDROSTATIC TEST	Raise to 1 1/2 Times computed Working Pressure* Lower to 1 1/2 and hammer, raise to 1 1/2 and Inspect (W-525)	Raise to 1 1/2 Times computed Working Pressure* and Inspect for Leaks. (R-525)

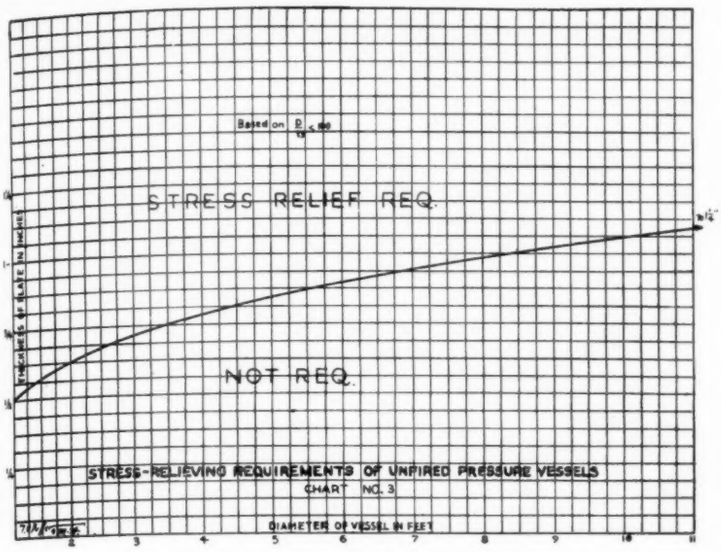
TEST REQUIRED	JOINT TENSION	BEND	REVERSE BEND	NICK	ALL WELD TENS
DOUBLE WELD BUTT	One	One	One	One	One
SINGLE WELD BUTT WITH BACKING UP STRIP	One	One	One	One	One
SINGLE WELD BUTT WITHOUT BACKING UP STRIP	One	One	Two	One	One
ALL LAP JOINTS	Two	None	None	Two	None

JOINT TENSION		Equal to Minimum of Specified Tensile Range of Plate x 1.1 x Joint Eff.** (W-520)
BEND		30% Elongation on outside for Stress-relieved Welds; 20% " " " " Unstress-relieved Welds (W-521)
REVERSE BEND		Same as Bend Test (W-521)
NICK BREAK		To show complete penetration of Weld (See W-522)
ALL WELD METAL	TENSILE	Equal to minimum of Plate Welded
	ELONGATION	20% in 2" for Stress-relieved Welds. 15% in 2" for Unstress-relieved Welds

CHART NO. 1

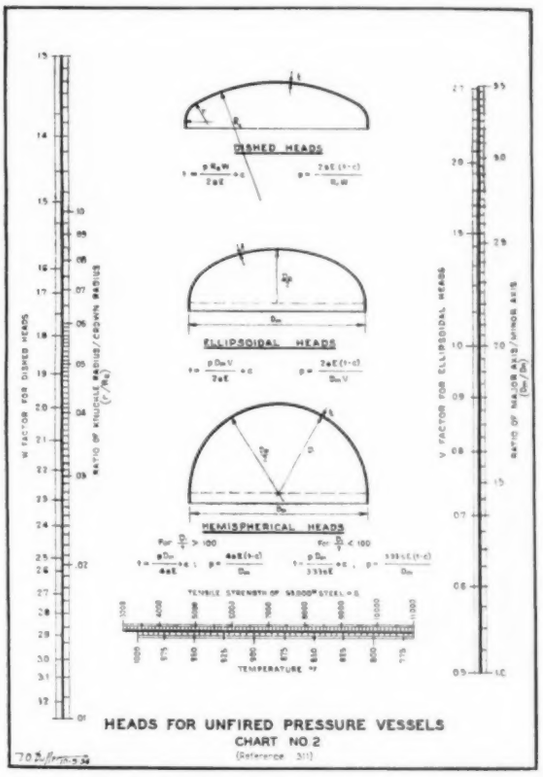
* Defined as Working Pressure computed for Atmospheric Temperature.

** Need not exceed Minimum Specified Tensile Strength of Plate

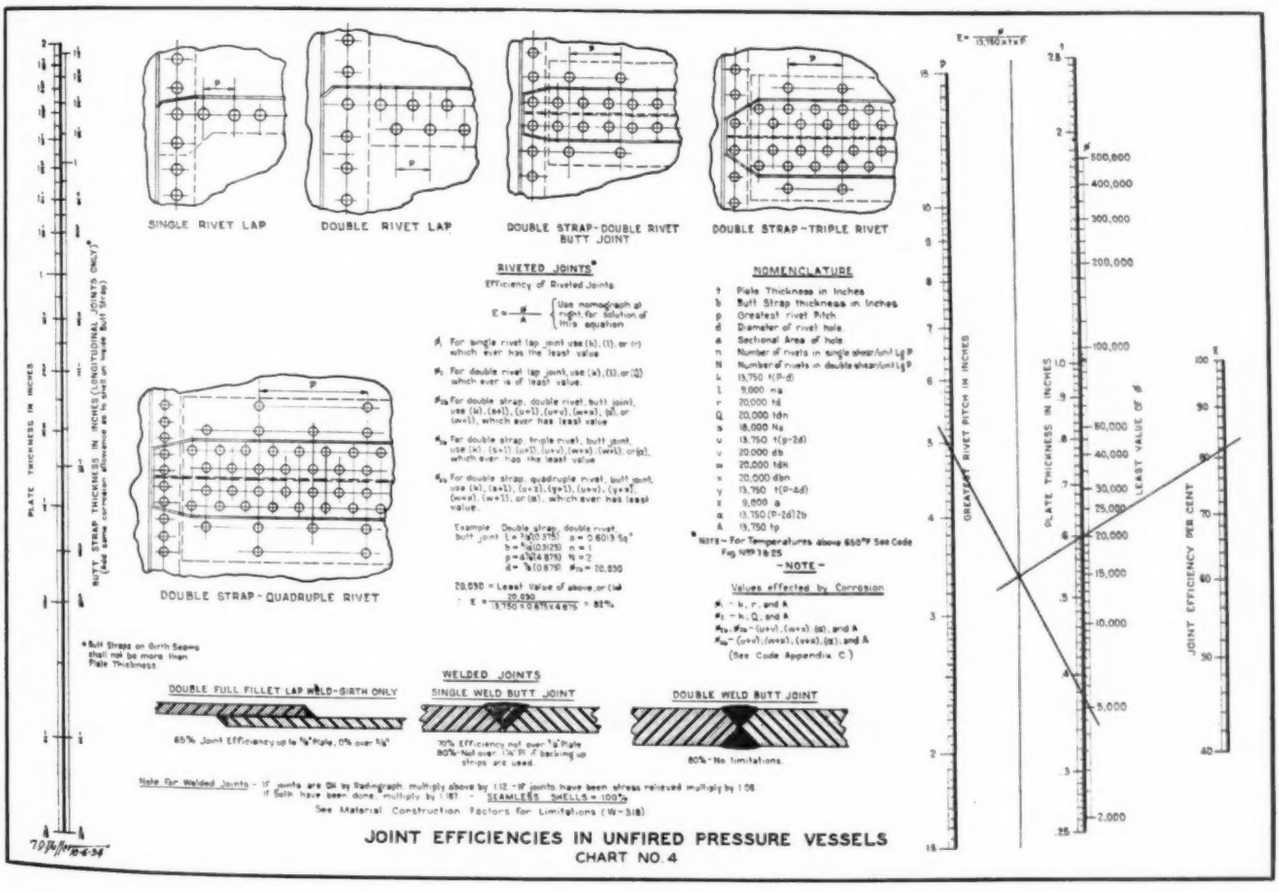


STRESS-RELIEVING REQUIREMENTS OF UNFIRED PRESSURE VESSELS
CHART NO. 3

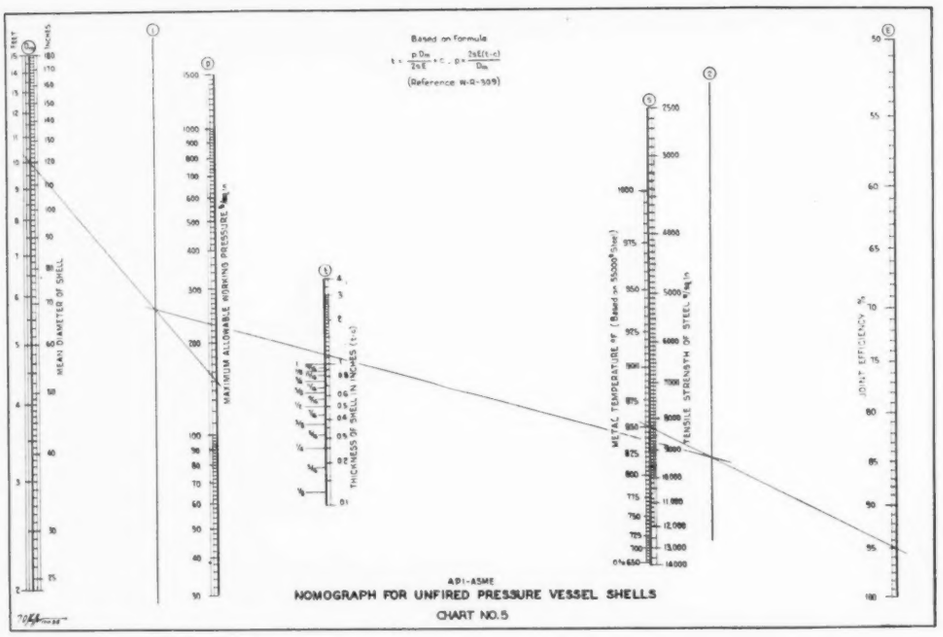
E = Joint efficiency. (See text for explanation).
hg = Radial distance from bolt circle diameter to the diameter of gasket in inches.
H = Total hydrostatic end force on area bounded by D in pounds.
K = 1/.09 to provide extra reinforcement to compensate for nozzle wall hoop stresses.
n = Nozzle wall thickness in inches.
p = Maximum allowable working pressure in lb. per sq. in.
r = Knuckle radius of dished heads in inches measured to the center line of the plate.
Rc = The crown radius of dished heads in inches measured to the center line of the plate.
s = Maximum allowable working stress, in tension, of steel.
t = Minimum thickness in inches.
t_1 = Equivalent vessel wall thickness for partially reinforced openings.
V = Factor for ellipsoidal heads.
w = bolt load on flat cover plates assumed to be 2H.



HEADS FOR UNFIRED PRESSURE VESSELS
CHART NO. 2
(Reference 311)



JOINT EFFICIENCIES IN UNFIRED PRESSURE VESSELS
CHART NO. 4


Based on formula
(Reference W-R-309)
MEAN DIAMETER OF SHELL
MAXIMUM ALLOWABLE WORKING PRESSURE
THICKNESS OF SHELL IN INCHES (t-c)
METAL TEMPERATURE °F (Based on 55000 Sm)
TENSILE STRENGTH OF STEEL
JOINT EFFICIENCY

API-ASME
NOMOGRAPH FOR UNFIRED PRESSURE VESSEL SHELLS
CHART NO.5

of the chart is for the convenience of solving the joint efficiency of riveted joints when the lease value of Φ has been determined. It should be noted that the values given as constants under the nomenclature are correct only for joint temperatures up to 650 deg. fahrenheit. For temperatures above 650 deg. fahr., these values will be lowered in accordance with Figs. 1 and 25, found in the code. (Reference W-R-320, Appendix C).

Chart No. 5 is based on the formula for thickness of shells using the diameter D*m* as the mean diameter. Any corrosion allowance desired should be added to the value of t, found by the use of the chart. (Reference W-R-309).

Chart No. 6 is based on the formula for ellipsoidal heads. (Reference W-R-311a).

W = Factor for dished heads.
X_1 = The reinforcing area of metal in the nozzle wall and additional plates and welds other than the vessel wall within the reinforcing zone in square inches.

The new A.P.I.-A.S.M.E. code for unfired pressure vessels has filled a long-felt need in the petroleum industry. While the first edition of the code has been compiled to a form for easy reference, the various formulae for design have necessarily been separated throughout.

In order to have a more flexible and ready means for preliminary calculations and for checking the various major parts of a vessel, a number of nomographs and charts were constructed and assembled, which, it is felt, will lend themselves to ease of checking both new and existing vessels.

The charts have been made not with the idea of eliminating the use of the code but rather as a supplement to it, when detail calculations are not required. The code specifications should be thoroughly understood in all their details or used as a reference when an analysis of a vessel is undertaken.

Chart No. 1 is a general summary of the code requirements for both fusion-welded and riveted construction. Paragraph numbers corresponding to the code paragraph are shown for convenience and reference when more detail is desired.

Chart No. 2 is a summary of heads generally constructed on unfired pressure vessels. The conical and flat heads have been purposely neglected, since they are rarely used. (Code reference W-R-311).

Chart No. 3 provides a ready means of determining the stress-relieving requirements for a vessel (based on the formula

$$\frac{D}{t^3} < 100).$$

(Code reference W-318-3).

Chart No. 4 is a summary of the joint efficiencies for both fusion-welded and riveted joints. The nomograph on the right end

Chart No. 7 is based on the formula for dished heads. (Reference W-R-311b).

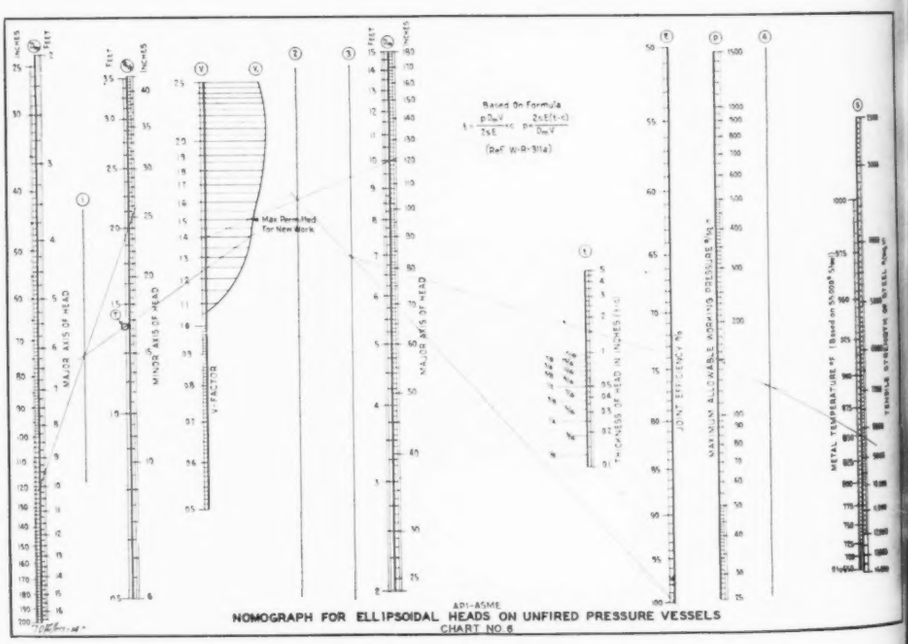
Chart No. 8—A means for determining X_1, when nozzle and reinforcing are fusion-welded, X_1 being the area of the metal in the nozzle wall and the additional reinforcing metal within the reinforcing zone over that available in the vessel wall if any. (Reference W-329).

Chart No. 9 is based on the formula for determining the thickness of bolted flat cover plates over 14 in. in diameter, using ring type gaskets. (Reference W-R-316).

Chart No. 10 is a means of determining the factor "C" used in Chart No. 9.

Chart No. 11 is a deviation from the formula for fusion-welded reinforced nozzles. It may be used for the strength of existing nozzles that are insufficiently reinforced.

For the economic design of a vessel, the proper coördination of all its parts is essential; that is to say the vessel is no stronger than its weakest part. Obviously, there is no economy in constructing a vessel with a head that is stronger than the shell, nor is it economy to construct a nozzle with more reinforcing than that required to equal the strength



API-ASME
NOMOGRAPH FOR ELLIPSOIDAL HEADS ON UNFIRED PRESSURE VESSELS
CHART NO. 6

Reduced Power Cost
Lower Maintenance Cost
No Wear on Tubing or Casing
Over-All Efficiencies of 50% to 75%
Extends Economical Pumping to Greater Depths
KOBE

Proved

by more than 3 years of actual field service.

For more than three years a number of Kobe Pumps have been operating continuously in different fields, under widely varying service conditions. Every operation of each of these installations has been carefully checked and recorded. Power costs; maintenance costs; complete operating costs; mechanical, hydraulic, and over-all efficiencies; wear and tear; pumping and production records; all have been accurately tabulated. Without exception these installations are setting new standards of efficiency and economy in pumping oil from various depths.

Kobe statements regarding performance, efficiencies and costs are not estimates. They are actual records of Kobe units in service under a wide range of operating conditions. In no instance are they overstatements of actual results obtained.

Sufficient data have been accumulated from these units to enable Kobe engineers to predict the performance of any proposed installation with reasonable accuracy. We invite any interested oil company to examine these records, and to ask for estimates of performance, costs, et cetera, covering any well or group of wells.

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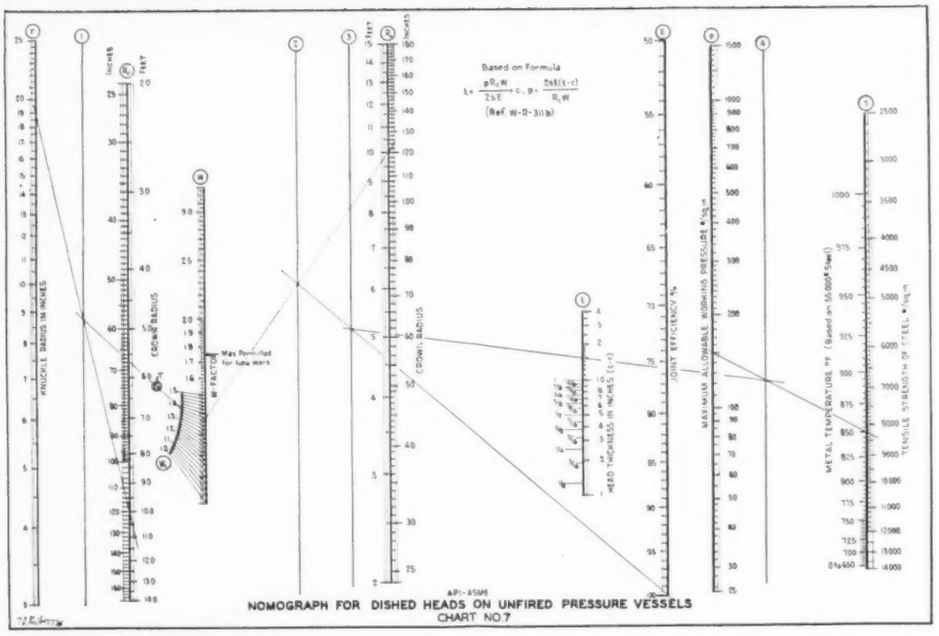


NOMOGRAPH FOR DISHED HEADS ON UNFIRED PRESSURE VESSELS
CHART NO. 7

of the shell or head.

The charts all deal with the net minimum metal thickness. Any corrosion allowance is purely additive and may be uniform throughout the entire vessel or added only where localized corrosion is expected. This additional metal for corrosion protection is assumed to have no other duty, and is entirely neglected when the strength of a vessel or any of its parts is calculated, either in new or existing vessels.

To exemplify the use of the charts, a vessel of an assumed special design will be calculated as shown in Fig. 1. The vessel is assumed to have no wind or static loads imposed upon it, and it is desired to provide for an internal pressure of 150 lb. per sq. in. with a maximum metal temperature of 850 deg. fahrenheit.

It should be borne in mind that this temperature is not necessarily the operating temperature, but the actual maximum metal temperature in any part or parts of the vessel. This temperature may be either estimated with allowance for the uncertainty or determined from existing vessels under identical conditions. (See paragraphs W-R-302-303 for further detail).

Deviating from the usual in order to illustrate the more common heads, a one-piece ellipsoidal head is shown in the top, and a one-piece dished head is shown in the bottom.

Two 20-in. manways are shown — one in the center of the top head and one in the virgin plate on the side of the shell; 55,000-lb. carbon steel, meeting the A.S.T.M. firebox grade, will be used.

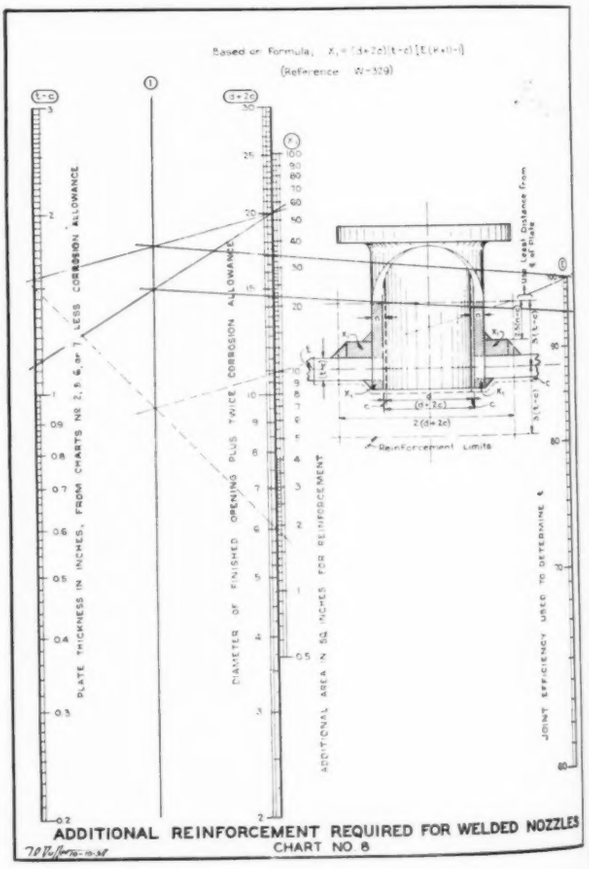
It is also assumed that the vessel will be both stress-relieved and radiographed in order to gain the maximum joint efficiency of 95 per cent.

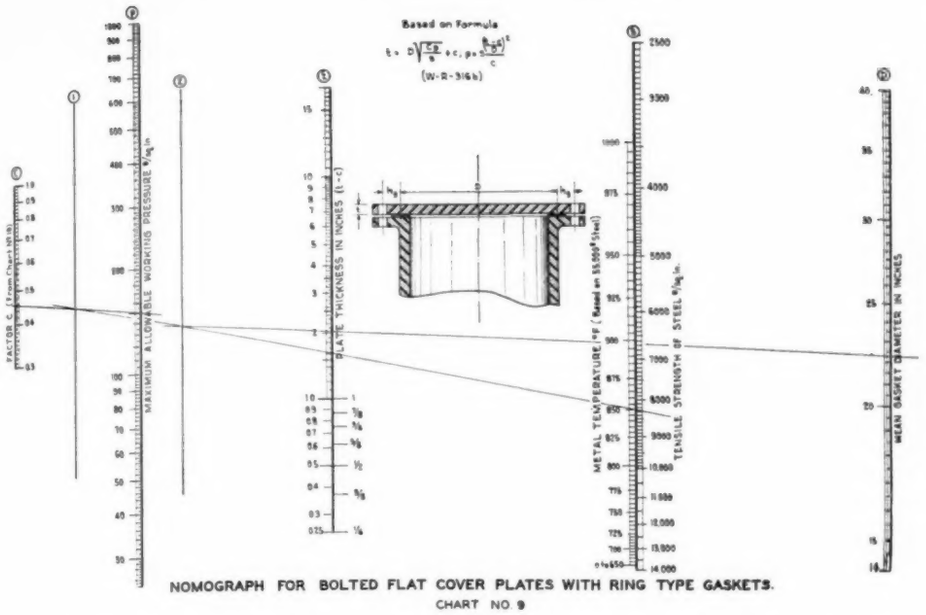
First, the shell thickness will be determined by referring to Chart No. 5. On scale D*m* on the left of the chart locate the mean diameter as 120 inches. On scale p locate the pressure 150 lb. per sq. inch. A straight line drawn through these points will locate a point of intersection on line scale No. 1. The next step will be to locate the joint efficiency 95 per cent on scale E, and the metal temperature on scale s. A straight line drawn through these two points will locate a point of intersection on line scale No. 2. Connecting the two points on line scales No. 1 and 2, thus located, with a straight line, will intersect the t scale at the required shell thickness, i.e., 1⅛ inch. The corrosion allowance desired will be added to the inside of the vessel and to the 1⅛-in. thickness.

Second, the top head thickness will be determined by referring to Chart No. 6 for ellipsoidal heads. As will be noted in Fig. 1, one-half the minor axis of the center elipse is two ft. or 24 in., and the major axis is ten ft., or 120 inches. This ratio is not the most efficient ratio but is used here in order to demonstrate the variation in the chart.

Locate the major axis, or 120 in., on scale D*ml*. On scale D*n*/2 locate 24 inches. A line drawn through these two points will locate a point at the intersection on line scale No. 1. From this point, a line drawn through the turning point marked T and continued to V_1 will locate a point at the intersection of scale V_1. From this point on V_1 a line drawn parallel with the horizontal divisions to scale V will locate the V factor of 1.4. From 1.4 thus locate on scale V, a straight line drawn through 120 in. on scale D*m* will locate the point of intersection with line scale No. 2. From this point of intersection with line scale No. 2, a straight line drawn through 100 per cent joint efficiency (the head being one piece) on scale E will locate a point at the intersection on line scale No. 3.

Locating a point of intersection on line scale No. 4 by connecting 150 lb. per sq. in. on scale p and the metal temperature 850 deg. fahr. on scale s and connecting this point and the point located on line scale No. 3 with a straight line will locate the thickness of the head on scale t or 1 9/16 inches. This also does not include any corrosion allowance.


Based on Formula
(Reference W-329)
PLATE THICKNESS IN INCHES, FROM CHARTS NR 2, 5 & 7, LESS CORROSION ALLOWANCE
DIAMETER OF FINISHED OPENING PLUS TWICE CORROSION ALLOWANCE
ADDITIONAL AREA IN SQ. INCHES FOR REINFORCEMENT
JOINT EFFICIENCY USED TO DETERMINE t
Reinforcement Limit
ADDITIONAL REINFORCEMENT REQUIRED FOR WELDED NOZZLES
CHART NO. 8



NOMOGRAPH FOR BOLTED FLAT COVER PLATES WITH RING TYPE GASKETS.
CHART NO. 9

Third, the thickness of the dished head will be determined by referring to Chart No. 7. On scale r locate the knuckle radius 19 inches. On scale R*cl* locate the crown radius 120 inches. A straight line drawn through these two points will locate a point at the intersection on line scale No. 1. A line drawn through this point and the turning point T will intersect scale W_1. Following the radial graduations from this point to scale W or 1.36.

The treatment for the remaining chart is identical with Chart No. 6 for ellipsoidal heads just described. As before, the value t of 1½ in. does not include a corrosion allowance.

Fourth, the additional reinforcement required for the manway opening in the top head will be determined by referring to Chart No. 8. As shown on Fig. No. 1 the diameter of the finished opening is 20 inches. As no corrosion allowance has been provided, this dimension will be 20 in. when calculating the reinforcement. In Chart No. 6 for the thickness of the head, a joint efficiency of 100 per cent was used. Therefore, 100 per cent will be used in determining the reinforcement, and t as 1 9/16 in. without corrosion allowance. If the thickness of the head or 1 9/16 in. is located on scale t-c and the diameter of the finished opening, or 20 in., is located on scale d + 2c and a line drawn through these points, an intersecting point on line scale No. 1 will be located. Connecting this point on line scale No. 1 with 100 per cent joint efficiency on scale E with a straight line will locate the additional reinforcement required over that available in the vessel head, on scale X_1, or 34.37 sq. inches. This area includes the area available in the nozzle walls within the reinforcing zone, as shown on chart or in paragraph W-329 of the code. Any reinforcing area placed within the vessel should be increased for corrosion allowance as shown on outline in sectional illustration on chart.

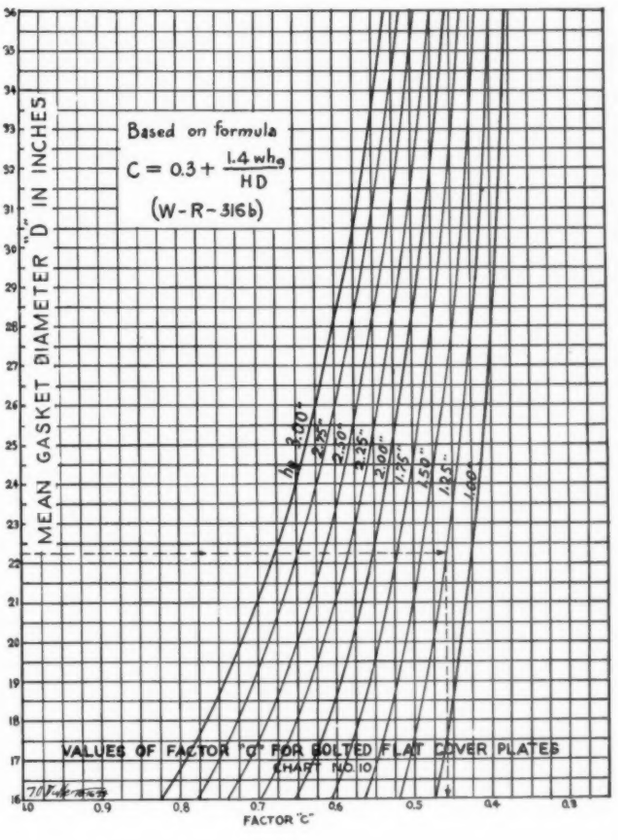
The reinforcement for the manway in the shell may be similarly determined by using the 95 per cent joint used in determining the thickness of the shell. If this manway has been located on a longitudinal seam, the treatment would have been somewhat different; i.e., the joint efficiency used on scale E of Chart No. 8 would have been 100 per cent. At first thought this seems absurd, but with a little reasoning we believe this will be made clear.

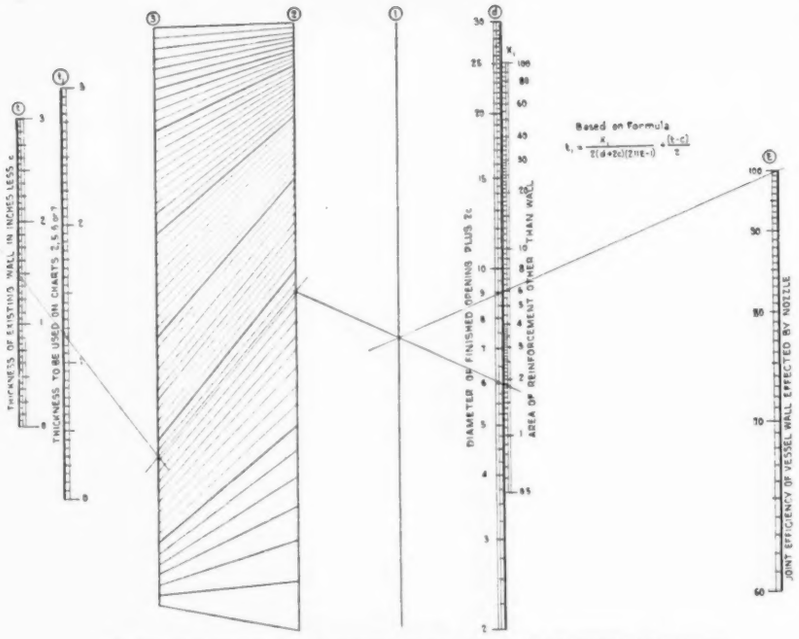
When a joint efficiency of less than 100 per cent is used in a longitudinal shell joint or a built-up head joint, the joint becomes the weakest part of the joined plates. In order to make this weakest part equivalent to the actual required plate thickness the plate thickness is increased. For instance, the thickness of a plate joined with a 95 per cent efficient joint is increased by approximately five per cent over that actually required. It is therefore obvious that the virgin plate will be equivalent to approximately 105 per cent, and that this five per cent additional metal may be considered as a part of the total reinforcing area within the reinforcing zone when an opening is entirely in the virgin plate.

Now, in a seamless shell or head the metal thickness has not been increased over that actually required, and therefore an opening in such a shell or head will necessarily have its entire reinforcement, or 100 per cent, as additional reinforcement.

Again, an opening placed where a longitudinal seam passes through it, regardless of the joint efficiency, will have its entire reinforcement as additional reinforcement for the reason that the full plate thickness is required at the joint or at the weakest part. For instance, the plate joined by a 95 per cent efficient joint was increased approximately five per cent over that actually required solely to make the joint equivalent to the actual required plate thickness, and therefore this five per cent is not available for reinforcement at the joint.

In using Chart No. 8 it should be remembered that the value of E will depend upon the value used for E in calculating the thickness t in that part of the vessel affected by the opening in question *except* when the opening passes


Based on formula
C = 0.3 + 1.4 whg / HD
(W-R-316b)
MEAN GASKET DIAMETER "D" IN INCHES
VALUES OF FACTOR "C" FOR BOLTED FLAT COVER PLATES
CHART NO. 10
FACTOR "C"


Based on formula
THICKNESS OF EXISTING WALL IN INCHES LESS c
THICKNESS TO BE USED ON CHARTS 2, 5, 6 or 7
DIAMETER OF FINISHED OPENING PLUS 2c
AREA OF REINFORCEMENT OTHER THAN WALL
JOINT EFFICIENCY OF VESSEL WALL EXPECTED BY NOZZLE

EQUIVALENT VESSEL WALL THICKNESS FOR PARTIALLY REINFORCED OPENINGS
CHART NO. 11

through a longitudinal joint or a joint in a built-up head and then the value E to be used on the chart will be 100 per cent.

As provided by the code, additional thickness may be added, if desired, to the plate over that actually required for the sole purpose of reinforcement.

Fifth, the cover plate thickness for the manways will be determined by using Charts No. 9 and 10. From Fig. 1, it will be noted that the mean gasket diameter is 22¼ in. and the radial distance from the diameter of gasket to the bolt circles diameter is 1¼ inches.

To determine the factor C for Chart No. 9, Chart No. 10 will be used. By entering the chart with a straight line drawn horizontally from the mean diameter of the gasket (22¼ in.) on the left to the curve hg marked 1.25 in., and then dropping perpendicularly to the bottom of the chart, it will be seen that the value of C will be 0.45 (approximately).

On scale C (Chart No. 9) locate this value 0.45. On scale p locate 150 lb. per sq. inch. A line drawn through these two points will locate a point on line scale No. 1. Connect this point on line No. 1 and 850 deg. fahr. on scale s with a straight line and a point will be located on line scale No. 2. A straight line through this point and 22¼ in. on scale D will locate the thickness required on scale t. This also does not include corrosion allowance.

Thus the major details of the vessel have been solved.

As an example, to illustrate the use of Chart No. 11, it will be assumed that an existing six-in. inside diameter nozzle, located in a seamless shell having a thickness of 1½ in., has only six sq. in. of external reinforcing. Using Chart No. 8 to check this nozzle, it is found that ten sq. in. are required. It therefore becomes necessary to determine the allowable working pressure of the nozzle. On scale E (Chart No. 11) locate 100 per cent, since the shell is seamless. Locate six sq. in. on scale X_1. By drawing a straight line through these two points, a point of intersection is located on line scale No. 1. On scale d locate six in. as the diameter of the opening in nozzle and draw a line through this point and the point located on line scale No. 1, and intersect line scale No. 2. From this point follow the radial transposition lines to line scale No. 3 and locate a point. From this point a line drawn through the shell thickness t (1.5 in.) will locate a value on scale t_1, of 1 3/16 inches.

The value of t_1 should then be used on Chart No. 5 to determine the allowable working pressure. Similarly, partially reinforced openings in the heads may be solved for strength by using t_1 from Chart No. 11 on corresponding Charts Nos. 2, 6, or 7.

It should be borne in mind that these charts do not include corrosion allowance and that the scales s are all based on 55,000-lb. steel. The corresponding values for any metals other than 55,000-lb. ultimate may be found by ratio.

For instance, a 60,000-lb. tensile strength carbon steel may be used and operated at 850 deg. fahrenheit. It will be noted on the scales that the 55,000-lb. steel is valued at 8,250 lb. Assuming that the steel has an ultimate stress of 60,000 lb. in its annealed condition (see note under Fig. 1 of code), the working stress will therefore be:

$$\frac{60{,}000 \times 8250}{55{,}000} \text{ or } 9000 \text{ lb.}$$

This value would be used in the right-hand side of the s scales in place of the temperature side, when using the charts under such circumstances.

Charts Nos. 5, 6, and 7 may be used for riveted vessels when the joint efficiency has been determined.

The original nomographs are accurate in their averages to within five per cent. To work within this limit of accuracy it is necessary that all lines made in applying the charts be properly drawn. Distortion due to reproduction will alter this accuracy. It will be apparent that any value may be determined when the remaining values are known.

The methods of chart construction have not been given here, but those who desire to construct charts of their own may find ample practical information from various books published on the subject.

Reference is made to *The Chemist-Analyst*, Vol. 20, No. 6; Vol. 21, Nos. 1 and 2, Perry's *Chemical Engineering Handbook*, Mark's *Mechanical Engineers' Handbook*, and Peddle's *"Construction of Graphical Charts."*

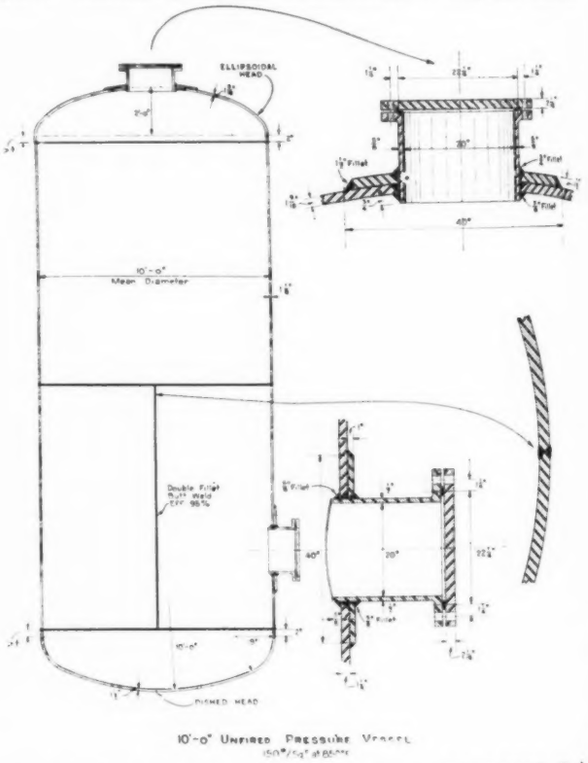


Fig. 1. Example for nomographic computations, A.P.I.-A.S.M.E. Code

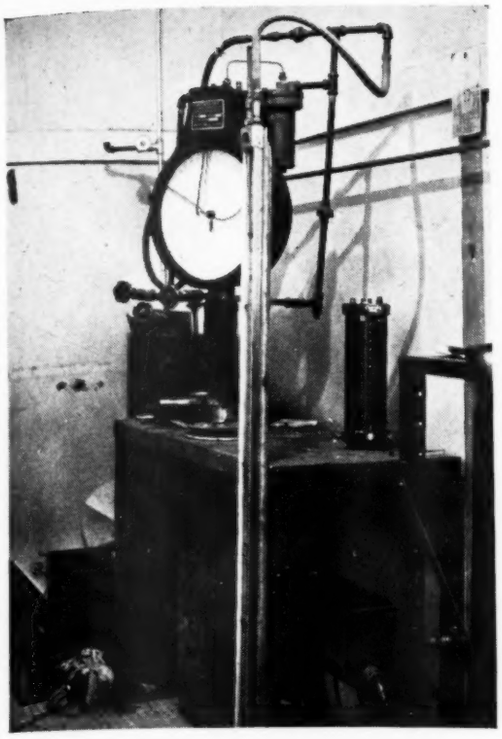


Fig. 1. Stand developed for checking orifice meters

Orifice Meter Maintenance

By

G. B. STEELE

New York Oil Company,
Casper, Wyoming

THE practice of checking orifice meters in place, though necessary in the event of disputes over accuracy of measurement, is not so satisfactory as a routine operation. It is the belief of the writer and his associates that orifice meters should be removed at regular intervals to a shop where they can be completely dismantled, thoroughly cleaned, reassembled, and checked against instruments over the full differential range. The value of this course has been demonstrated in many cases where meters have been cleaned with wire brushes and gasoline. The amount of dirt that would otherwise remain in the pressure chambers and U-tube connection can very seriously impair measurement.

The accompanying photograph (Fig. 1) shows a stand developed for this purpose. A steel table has been reinforced with welded strips so the top is rigid. The leveling table (Fig. 2), patterned after that of a surveyor's transit, is held to the table by a wing-nut beneath the top and the leveling is done by means of four machine bolts. A 2-in. pipe-collar is welded to the plate, and a 2-in. pipe nipple holds the meter at a convenient height. When not in use, the meter-stand can be removed and the table used for other purposes. In leveling, the top of the low-pressure chamber should be removed and a small steel or aluminum level used.

After re-assembly, the meter is leveled and checked against a manometer and test gauge. At this time, pen arms are so adjusted as to follow accurately the chart arc, and as close together as possible in order to eliminate time lag between static and differential. The connection used to obtain pressure against the high-pressure or up-stream side is shown in the photograph. It consists of a length of welding hose, coupled by a union to a tee-connection, with rubber tube connection to a 50-in. water manometer, or pipe connection to a 100-in. mercury manometer. Both manometers are shown with connection made to the 50-in. manometer. The pressure line to the meter is plugged at the tee, and varying differential pressures are obtained by manipulation of a valve in the supply line and the lefthand bypass valve bleeding to the air. The righthand bypass valve is closed.

For convenience, a comparison graph (Fig. 3) is used to compare manometer readings with square-root chart readings.

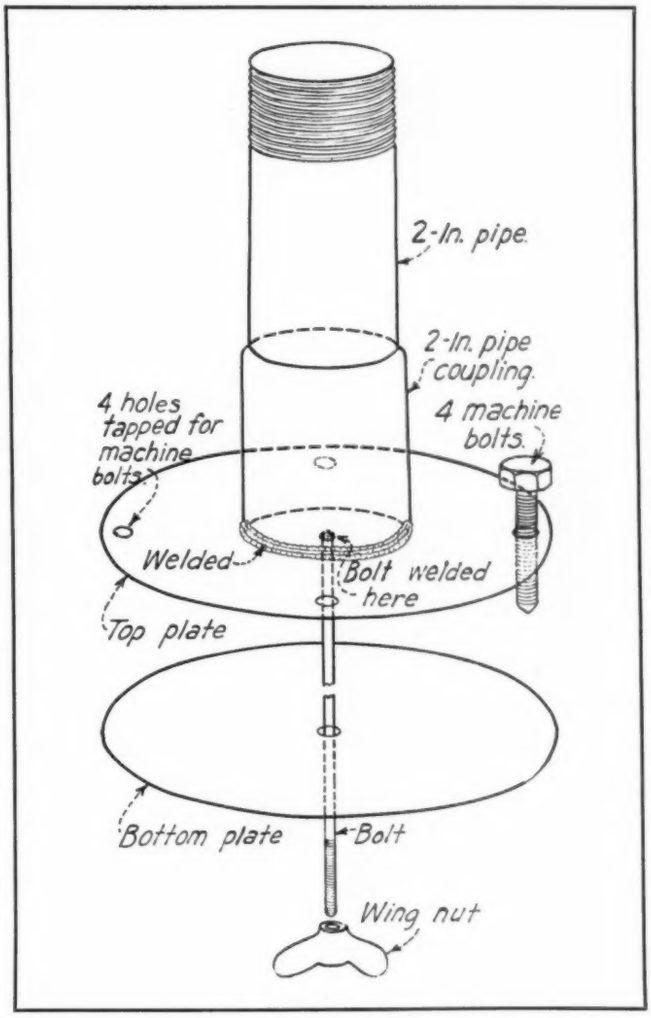


Fig. 2. Orifice meter leveling table

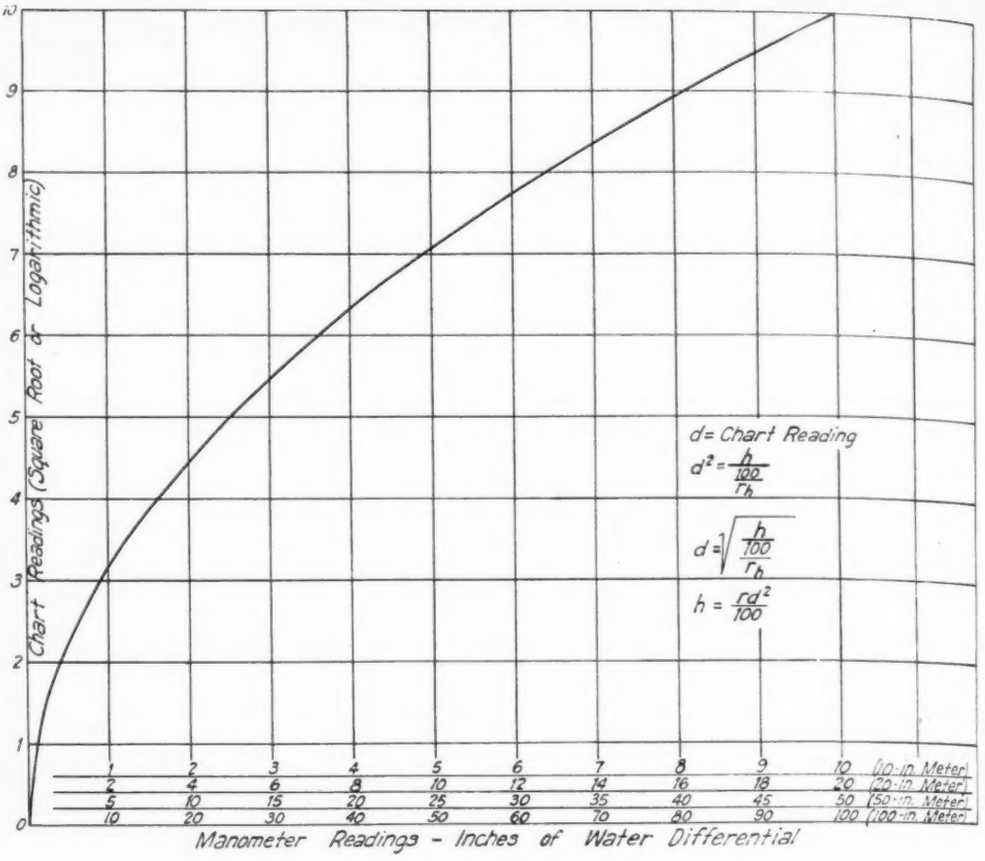


Chart Readings (Square Root or Logarithmic)
d= Chart Reading
$d^2 = \frac{h}{\frac{100}{r_h}}$
$d = \sqrt{\frac{h}{\frac{100}{r_h}}}$
$h = \frac{rd^2}{100}$
1 2 3 4 5 6 7 8 9 10 (10-in. Meter)
2 4 6 8 10 12 14 16 18 20 (20-in. Meter)
5 10 15 20 25 30 35 40 45 50 (50-in. Meter)
10 20 30 40 50 60 70 80 90 100 (100-in. Meter)
Manometer Readings - Inches of Water Differential

Fig. 3. Graph for comparing manometer readings with square-root chart readings

The test gauges used read either in lb. gauge, lb. absolute, or in chart readings for 50-lb. and 100-lb., or 250-lb. and 500-lb. meters. After testing, the meters are enameled, when necessary, with a gloss meter enamel and permitted to dry. During the drying period, a 24-hour run of the chart will check the accuracy of the clock.

Meters equipped with standard factory piping will be found to be readily interchangeable, facilitating removal and replacement. It is advisable to replace old springs when necessary with the new style spring assemblies, having replaceable springs, and old style cases with the newer square type cases whenever possible. This recommendation applies only to the make of meters used by our company.

It is the practice of our company to use only one chart, the logarithmic or square-root. Where direct readings of gauge pressures are necessary, such as in gasoline plants or compressor stations, a graph (Fig. 4) may be used.

The period of service between routine cleaning and checking will vary with the gases being measured, amount of dirt and scale in pipe lines, or other conditions. Clean mercury should always be used. A still and condenser constructed of pipe fittings may be used to re-distill dirty mercury with very satisfactory results.

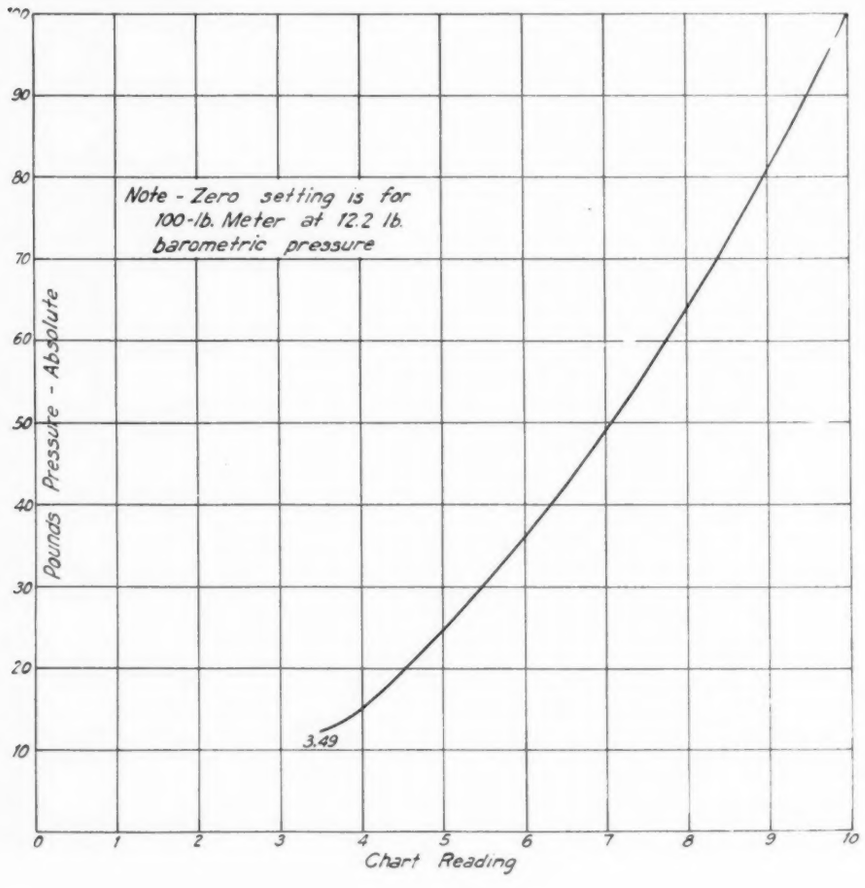


Fig. 4. Chart used where direct readings of gauge pressures are necessary, such as in gasoline plants or compressor stations

Engineering Fundamentals Department

- A Study Course for Field and Plant Men
- A Review for Experienced Engineers

W. L. NELSON
• K. C. SCLATER •
Editors

Elements of Applied Petroleum Production

Article 15
EQUIPMENT AND OPERATION OF OIL WELLS (Continued)

By K. C. SCLATER

FLOWING WELLS—Continued

BELT DRIVES. In last month's article we discussed power transmission in general and stated that belts are most widely used for this purpose on individually pumped wells. We shall now discuss belt drives more in detail, for they are an important item of cost in well-pumping operations.

There are two general classes of belts in use in the oilfields: the flat belt and the V-belt. Of these the flat belt is more universally used; within recent years, however, the V-belt has come into limited use for short drives such as that between a motor and a gear reducer on a well pumped by a gear-driven unit.

Belting is one item that has received the close attention of the standardization group of the A.P.I. since 1923. Complete specifications have been prepared for flat belts and these are now used throughout the industry by manufacturers and users alike. No specifications have yet been determined for V-belts although they have been under consideration by the committee on belting standardization.

These specifications recognize six type of flat belting for oil country use, as follows:

Leather Belting
Impregnated Stitched Cotton Fabric Belting
Solid Woven Hair Belting
Solid Woven Cotton Belting
Balata Belting
Rubber Belting

Leather belting is assumed to be of first quality oak-tanned leather. It is available in single, double, or triple thickness. It is required that the ultimate tensile strength be: for single belts, not less than 600 lb. per inch of width; and for double belts, not less than 1100 lb. per inch of width.

Impregnated stitched cotton fabric belting is made up of plies of uniformly woven duck, suitably stitched together with lock stitching. These stitches are required to be interlocked midway between the surfaces of the belting. Another requirement is that the finished belt shall be impregnated with a special compound that will lubricate the internal fibers of the belt. The ultimate tensile strength must be: not less than 300 lb. per inch per ply for belts up to and including 7-ply; and not less than 275 lb. per inch per ply for belts above 7-ply.

Solid woven hair belting is available in three principal thicknesses, designated as single, double, and triple. Finished belts are required to be impregnated with a special compound that will lubricate the internal fibers of the belt and will not be affected by extremes of temperature. These belts are required to have an ultimate tensile strength of: not less than 1200 lb. per inch width for belts of single thickness; not less than 1450 lb. per inch width for belts of double thickness; and not less than 1700 lb. per inch width for belts of triple thickness.

Solid woven cotton belting is made in three principal thicknesses designated as single, double, and triple, with a tolerance of only 1/32 in. plus or minus allowed. The finished belt is required to be impregnated with a special compound that will lubricate the internal fibers of the belt. The ultimate tensile strength must be: not less than 1200 lb. per inch width for belts of single thickness; not less than 2200 lb. per inch width for belts of double thickness; and not less than 2800 lb. per inch width for belts of triple thickness.

Balata belting consists of plies of uniformly woven duck, thoroughly impregnated with genuine balata gum solution and pressed together uniformly. The required ultimate tensile strength is: not less than 350 lb. per inch per ply.

Rubber belting is made up of plies of uniformly woven duck, frictioned with a rubber compound and vulcanized together in a uniform manner. The ultimate tensile strength must be not less than 320 lb. per inch per ply.

In addition to the foregoing specifications for each type of belt the elongation must fall within certain maximum and minimum limits when the belt is in tension. The elongation is plotted in per cent against the lb. pull per inch of ply or width. If on test the elongation fall within the prescribed limits they are considered satisfactory for oilfield service.

Before the introduction of these specifications, there was not much thought given to the suitability of belts for the duty demanded in oilfield service. In 1923, when the Belting Committee of the A.P.I. took up its work, many 10-in., 6-ply belts were being used and the standard for drilling and pumping, regardless of the service, was 12-in., 6-ply and 12-in., 5-ply belts respectively.[70]

The popular type of drive in common use for oil-well pumping is the familiar long-center open drive between the engine and the bandwheel such as is used on the standard pumping rig with a steam prime mover. Sometimes an idler is used between the bandwheel and the engine.

On a standard pumping rig quipment with a gas engine and where the engine is used for pulling rods and tubing or for cleaning-out, a countershaft with pulleys and reverse clutch is employed between the engine and the bandwheel. On rigs of this type, more recent practice is to use a short-center drive between the bandwheel and countershaft. Both the drive from the engine to the countershaft and that from the countershaft to the bandwheel may be equipped with endless belts. One reason for this is to get away from the use of belt clamps, as these might give rise to belt failure and be detrimental to the smooth transmission of power to the polished rod. Another reason is to permit the use of an idler, sometimes so essential to the efficiency of a short-center drive.

At one time it was estimated that probably one of the chief causes of belt failures was belt clamps. More than 75 per cent of belt failures occurred at the clamp, and it was believed that in a large portion of the remaining 25 per cent of failures the clamp was indirectly responsible.[71] Since these early investigations[70, 71] of belt failures were made many things have been learned about belt drives on pumping wells. Belt clamps were accepted as a necesary evil, but exhaustive tests and observation in the field made during the last ten years on belt fasteners have done much to improve the design of and method of applying belt fasteners, and so to reduce belt failures.

Care in applying belt clamps is very important. Stretching the belt to put on the clamp may sometimes stress the belt beyond the maximum load for which the belt is rated. This stretching is more harmful after the belt has been in use for some tme, for then the belt has less elasticity than it had when new.

Although the principles underlying the performance of a belt under load are quite involved and are often beyond the average man to analyse, there is certain available information of a useful and reliable kind in regard to belt drives in general that it is well to keep in mind.

A belt should be chosen for the maximum load on the well and not on the average running load. Momentary overloads during starting and also when pumping determine the belt drive required. Starting jerks, load fluctuations, peak loads, and other such irregularities cannot be ignored. In this connection it is important to consider the type of prime mover to be used at the well. The starting torque of the engine or motor must be taken into account. Every effort should be made also to eliminate load shocks in the well itself. By proper counterbalancing, not only is the maximum belt load very much reduced, but the entire load curve is smoothed out and heavy shocks or loads at reversal of pump stroke are also reduced, and also the life of the belt is thereby prolonged.

"A steam engine on a belted load seldom exerts much more than full load torque when starting, ordinarily the starting torque is less than full load. As to running overloads, a steam engine is capable of carrying considerable. Different designs of engines differ in this respect. Ordinarily, a belt computed with 25 per cent allowance according to the belt manufacturer's standard data is satisfactory."[72]

"Gas engines, gasoline engines, and Diesels have small overload capacity. They require external power of some sort for starting, ordinarily their load is clutched on to them rather smoothly after they are up to speed. As for running overloads, they can carry very little, seldom over 25 per cent. The fact is, that unlike a steam engine these engines are most economical of fuel when they have all the load which they can stagger under. Thus if they were rated at the load where they give best economy as manufacturer and user alike would wish, they would not carry overload at all. Practical necessity dictates that they be rated somewhat below the point at which they stall. Various manufacturers concede 15 per cent to 25 per cent. Thus in belting these engines to the load we need not fear starting loads, and running peaks can exceed 25 per cent of the nominal engine horsepower, only momentarily. For loads exhibiting extremely violent fluctuations, power above the engine overload capacity may be transmitted through the belt from the stored power in the engine flywheel for a very brief interval indeed.

"Thus for internal combustion engines a belt computed according to the belt manufacturer's standard data with an allowance of say 25 per cent or 35 per cent for the pulsating character of the load from such prime movers and for possible overloads . . . such a belt is ordinarily sufficient."[72]

Information regarding the starting torque of electric motors should be obtained, if possible, from the manufacturer of the motor for the purpose of determining belt drives. "The easiest way to figure problems from data . . . is to determine the size of belt required for full load horsepower, from the belting manufacturer's tabular data, and then increase the belt width from a consideration of the application, of manufacturer's torque guarantees and a knowledge of the amount by which actual motors are likely to exceed guarantees.

"There is one matter in this connection which is worthy of consideration in the design of drives where the belt speed is high. It is of no importance for drives where the full load speed of the belt is less than 4000 ft. per minute.

"Above 3000 to 4000 ft. per min., the effective pull which a belt can exert is not quite as great as at lower speeds because centrifugal force reduces the pressure between the belting and the pulley. Most motors develop their maximum torque at 2/3 to ¾ full speed. Thus when a belt must exert the most extreme effective tensions it has the advantage of somewhat improved grip on the pulley due to this reduction in speed. If the belt speed at normal operating load is 5000 ft. per min. this reduction of ¼ to 1/3 in speed at maximum torque gives an advantage of 10 per cent to 15 per cent while for a belt operating normally at 6000 ft. per min. the advantage is about 20 per cent. If we neglect this minor effect the error is on the safe side.

"Another matter which introduces considerable uncertainty into estimates of maximum torque and starting torque . . . the voltage of the motor. If a motor is operated at precisely the voltage for which it was designed, the voltage marked on its name plate, it will perform about as the manufacturer states. However, if the motor is operated where the pressure is ten per cent higher than normal, this motor will develop 20 per cent more torque at starting and 20 per cent more maximum torque than at normal voltage. Similarly, if operated 10 per cent below rated voltage, starting and stalling torques are reduced 20 per cent."[72]

The capacity of a belt does not always increase in proportion to the speed. At high speeds — that is, 3000 to 4000 ft. per min.—the effective pull that a belt can exert is not quite so great as at lower speeds because centrifugal force reduces the pressure between the belting and the pulley.

Pulley diameter is an important factor affecting the transmitting capacity of a belt. An 8-in. pulley, for example, will carry almost 20 per cent less load than a large pulley with the same belt, operated at the same speed, and pulled up to the same tension at no load. With smaller pulleys the effect is very much more marked. For example, other things being equal, the same belt operated at the same speed and the same no-load tension will carry only half the load on a 3-in. pulley that it will on a large one. Although these facts have been known roughly for years it is interesting to note that while a belt, due to its own stiffness, will exert a poorer grip than a large one, stiffness of the belt cannot be the whole cause. Very likely there may be some other effect not yet understood, for the decrease in relative capacity of a light double belt on a 4-in. pulley as compared with a large pulley does not seem to be greatly different from that of a single belt on pulleys of the same diameter.[72]

Double (flat) belts will not carry loads in proportion to their thickness. The corresponding increase in capacity is only 75 per cent of the thickness and not 100 per cent. Triple belts will transmit only about 2¼ times the load of a single belt and not three times. Both practical experience and laboratory tests prove the truth of these statements.[72]

The terms "long center drive" and "short center drive" used in connection with belt drives are defined as follows: "A long center flat . . . belt drive is a drive operating under such conditions of center and load, that the maintenance of tension in operation is principally due to sag in the belt.

"A short center flat . . . belt drive is a drive operating under such conditions of center distance and load, that the maintenance of tension in operation, principally by means of the natural sag in the 'slack' strand of the belt is impracticable and tension must be maintained by means of the elasticity of the belt or by mechanical or other special means."[72]

In short center drives the use of a gravity idler, it is well to remember, will give as efficient a drive with a high pulley ratio as with a low pulley ratio. The idler pulley assures a favorable wrap of belt on the smaller pulley regardless of the size of the larger pulley. A pulley ratio of 15 to 1 or 20 to 1 is entirely practicable; in fact the only limitation is the size of the larger pulley that it is feasible to install.

Such information as has just been outlined is useful in the solution of belt drive problems.

The selection of a suitable drive for a pumping well should be based on accurate data regarding the well itself and the probable loads to be encountered. Subsurface conditions such as the probability of water encroachment and the probable rate of decline of the well will govern the selection of a belt drive of the proper capacity. One of the most difficult angles to the problem is that of determining or estimating in advance the probable allowable rate of flow. This of course will depend on the curtailment regulations in force. At the present time this is one of the baffling aspects of the power problem concerning pumping wells. The fact that a potential test of the well may have to be taken at intervals may necessitate putting in a heavier drive than the circumstances really warrant. The power required on a potential test might be many times greater than that required to pump the well's allowable production.

Correct pulley ratios for power transmission systems on pumping wells under restricted production are outlined by Bennett,[73] who discusses in some detail belt speeds and engine speeds in their relation to maximum horsepower requirements at the well and maximum available power at the engine.

It is found that all loaded belts 'creep,' which is not to be confused with belt 'slip.' Creep is caused by the elastic elongation and contraction of the belt while it is on the pulleys and not while in the unsupported strands between the pulleys. The result of creep is the same as that of slip although the causes are radically different. Belts with cotton fabric base, such as rubber and balata belts, show less creep than leather belts. For belts of the ordinary commercial materials creep seldom exceeds 1 per cent of the belt speed and reaches 1½ to 2 per cent only in the case of oak leather belting under very heavy loads. It is usual to lump these two together as "creep and slip."[72]

Flat belt drives are in such widespread use that their proper care and handling are important and should be familiar to field men who have anything to do with their operation.

Belts when new or when put into service after repairs should be placed over the pulleys and pulled together with belt stretchers. Soft rope should be used if belt stretchers are not available. Endless belts should never be run on the pulleys; they should be placed over the pulleys.

When slack is taken up in a belt, a square should be used so the ends may be cut square. If cut in this manner it will prevent unequal strains being set up in the belt when in operation.

A belt should be run as loose as possible without slipping.

When belt clamps with filler are used, the filler should be replaced when it becomes sufficiently worn for the belt to start wearing at the clamps.

Belts should be kept free of grease, mineral oil, and dirt. If belt dressing is required, that recommended by the manufacturer should be used; should this not be available then use only vegetable castor oil on belts other than leather, and then only at such times as it becomes absolutely necessary. On hair and fabric belts use castor oil very sparingly and on balata and rubber belts only at such times as they have a tendency to slip. On leather belts use neat's foot oil and apply it on the outside of the belt.

●

QUESTIONS

1. Of three types of prime mover . . . steam engine, internal combustion engine, and electric motor . . . all of the same horsepower, which will, in general, have the
   (a) highest starting torque?
   (b) greatest overload capacity?
   (c) what effect will torque and overload have on the required belt capacity?
2. Why is it that the capacity of a belt does not always increase in proportion to its speed?
3. In what way does pulley diameter affect the power-transmitting capacity of a belt?
4. What distinguishes a short-center drive from a long-center drive?
5. What can you say about the load-carrying capacity
   (a) of a double (flat) belt in proportion to its thickness?
   (b) of a triple belt in proportion to its thickness?
6. What is belt creep?
   What is the difference between belt creep and belt slip in its effect on a belt's operation?

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71"A Study of A.P.I. Belting Specifications and Field Service," by H. M. Henderson, A.P.I. Standardization Bulletin No. 103.

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Elements of Applied Petroleum Pipe Line Transportation

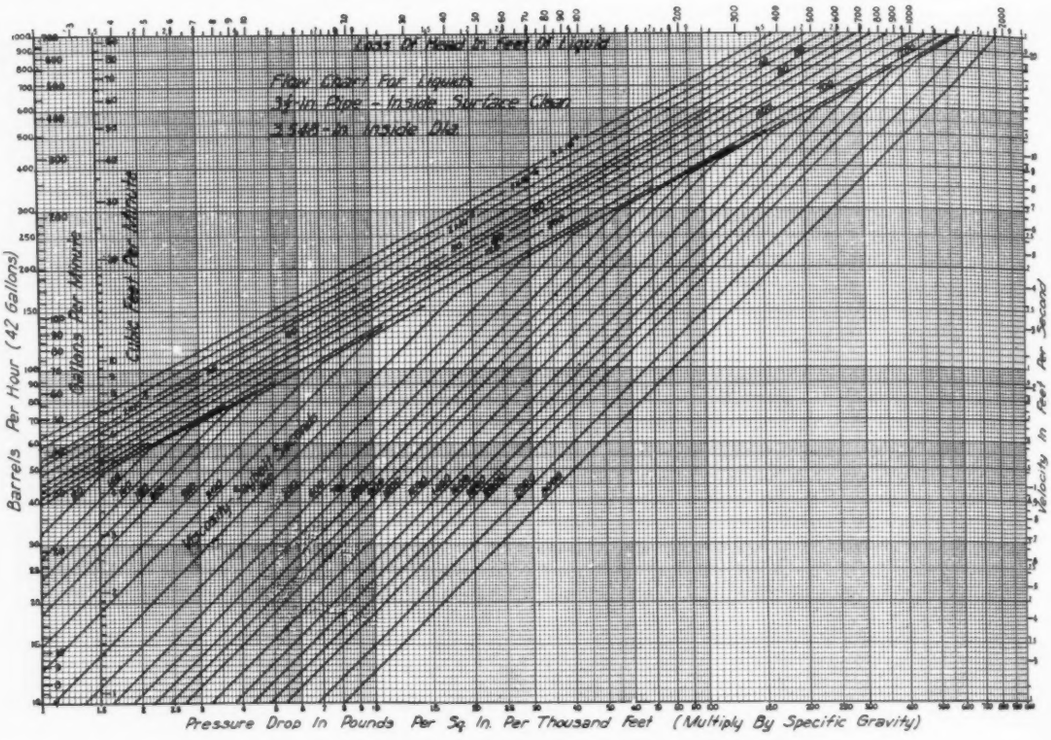
Article 6

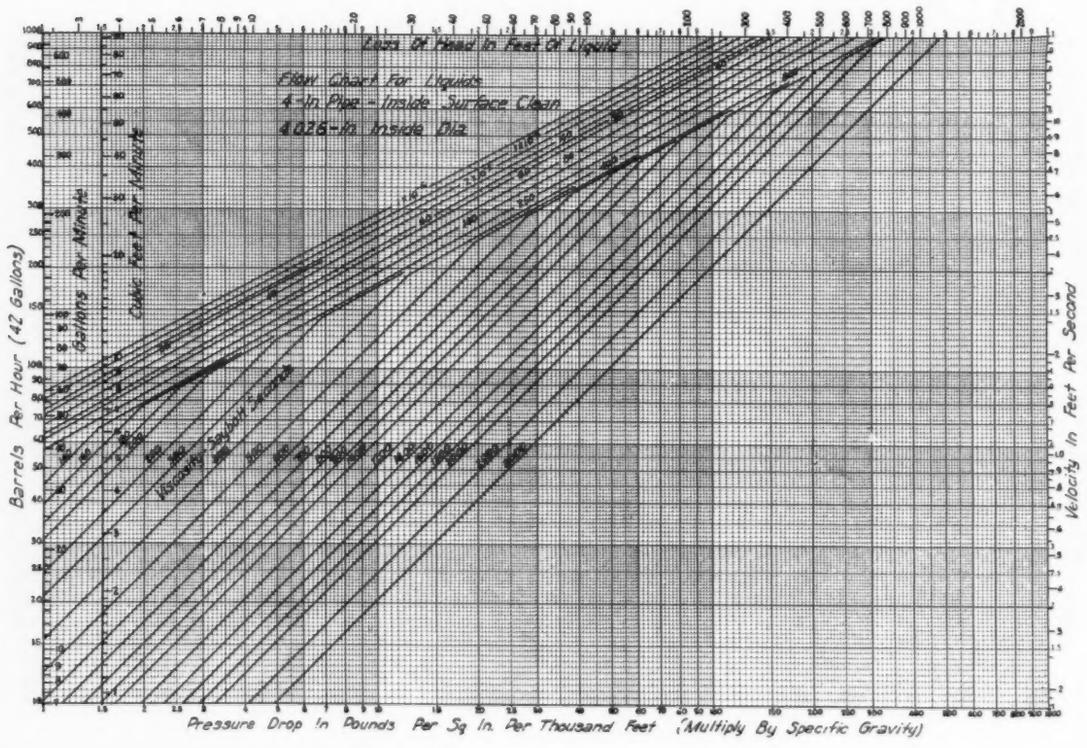
THE FLOW OF OIL IN PIPES AND PIPE LINES

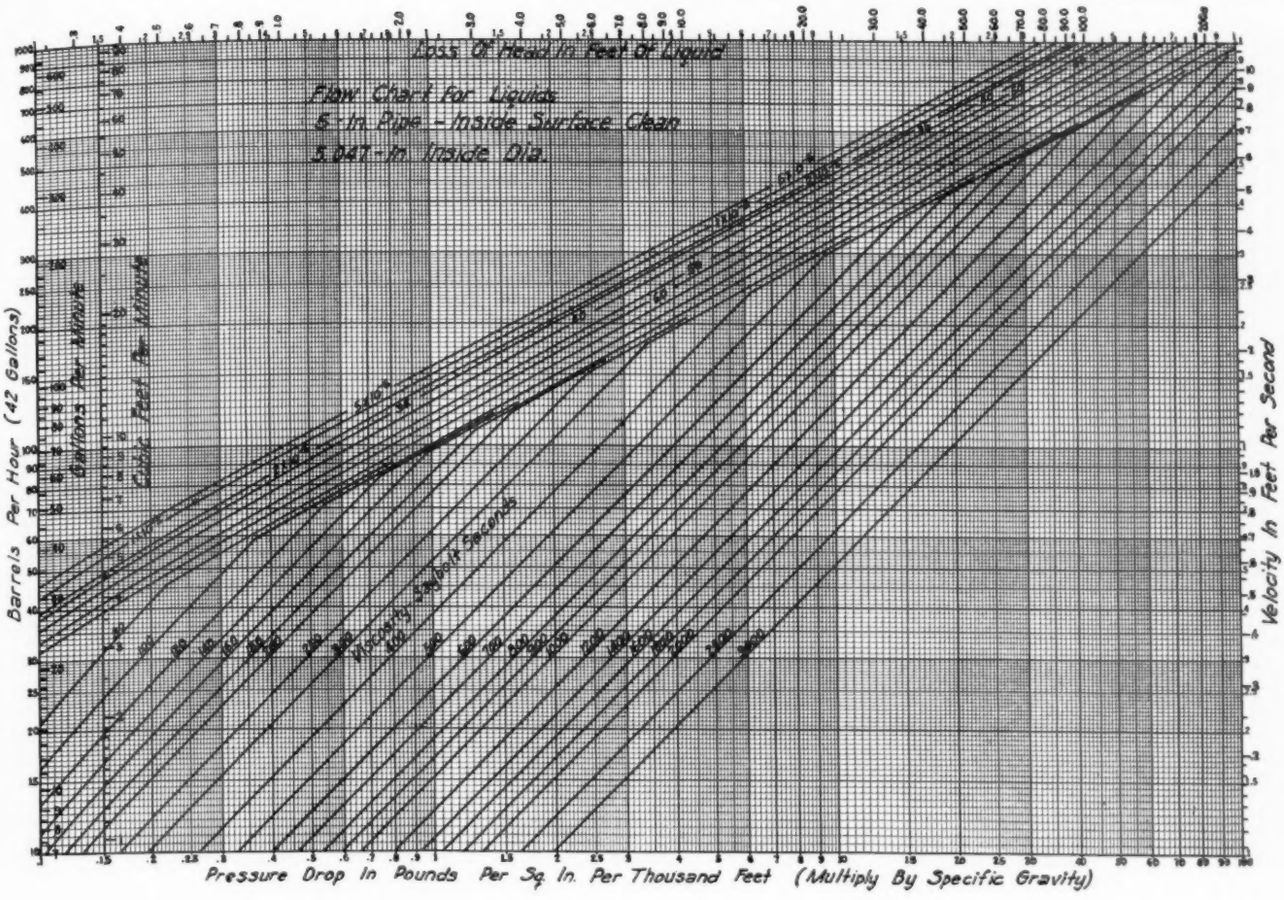
Part 6—Flow Charts

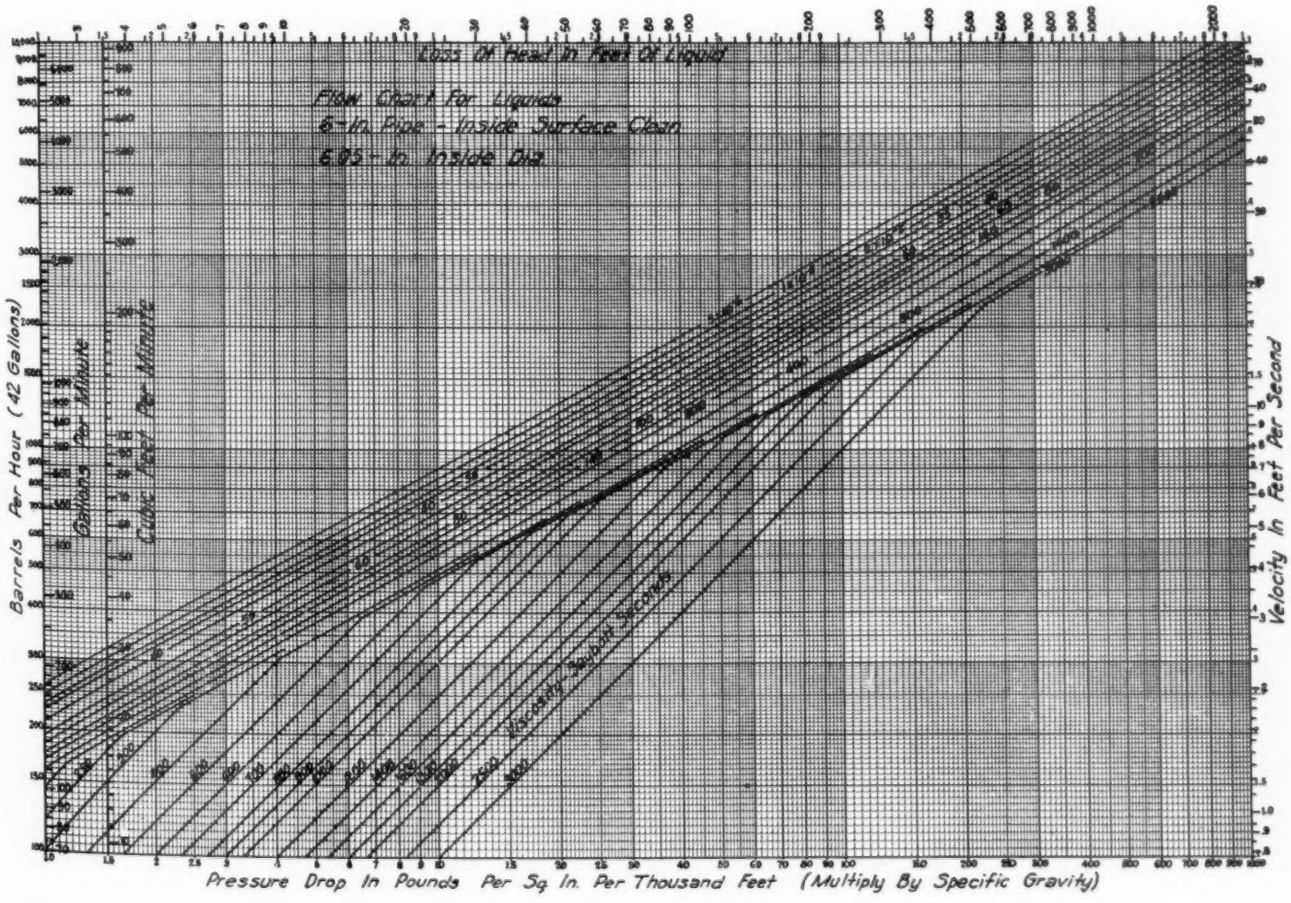
By EMORY KEMLER
and L. L. THOMAS

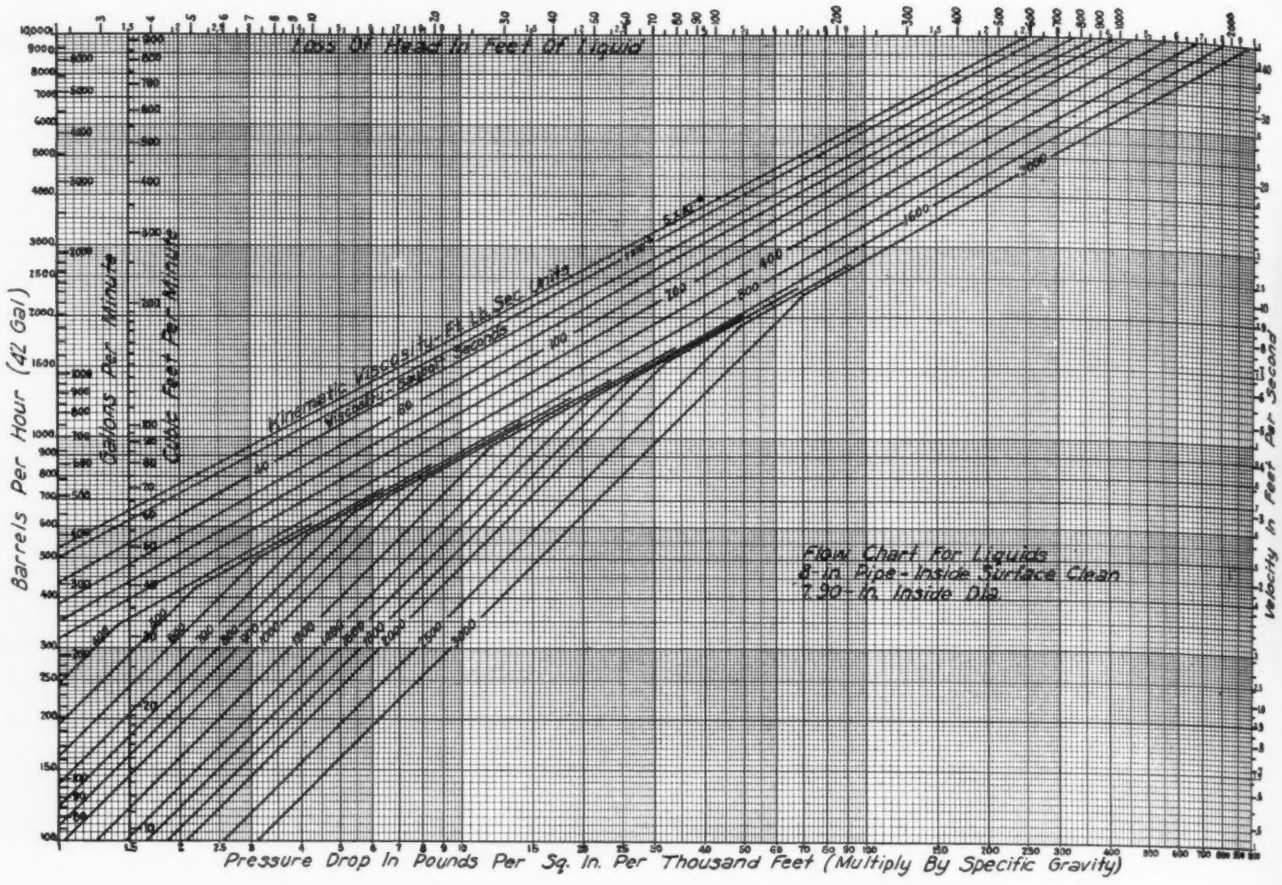
SIX more charts are given this month for the solution of flow problems in pipes and pipe lines, namely: 3½-in. pipe, 4-in. pipe, 5-in. pipe, 6-in. pipe, 8-in. pipe, 10-in. pipe.

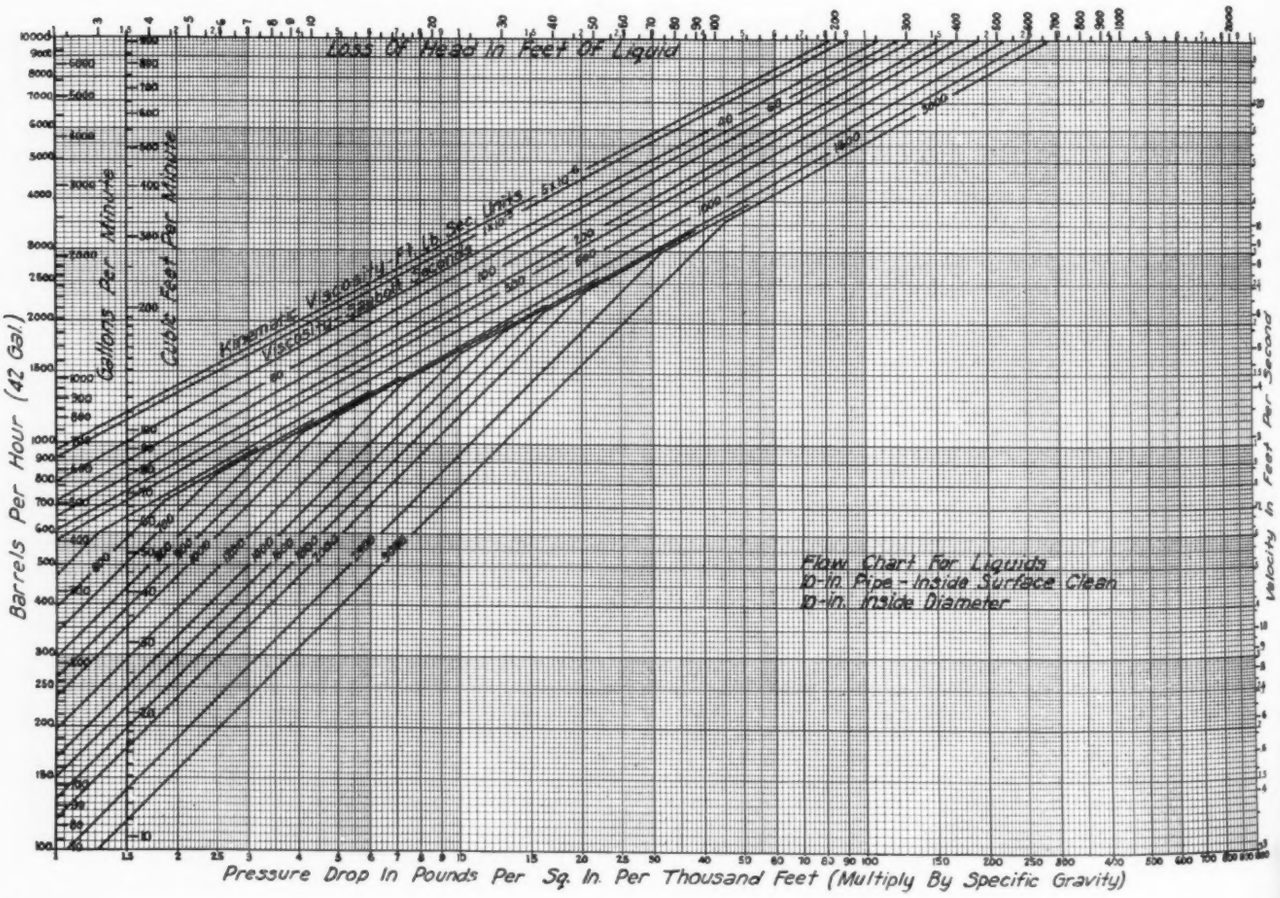

Loss Of Head In Feet Of Liquid
Flow Chart For Liquids
3½-in. Pipe - Inside Surface Clean
3.548-in. Inside Dia
Barrels Per Hour (42 Gallons)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Flow Chart For Liquids
4-in. Pipe - Inside Surface Clean
4.026-in. Inside Dia
Barrels Per Hour (42 Gallons)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)

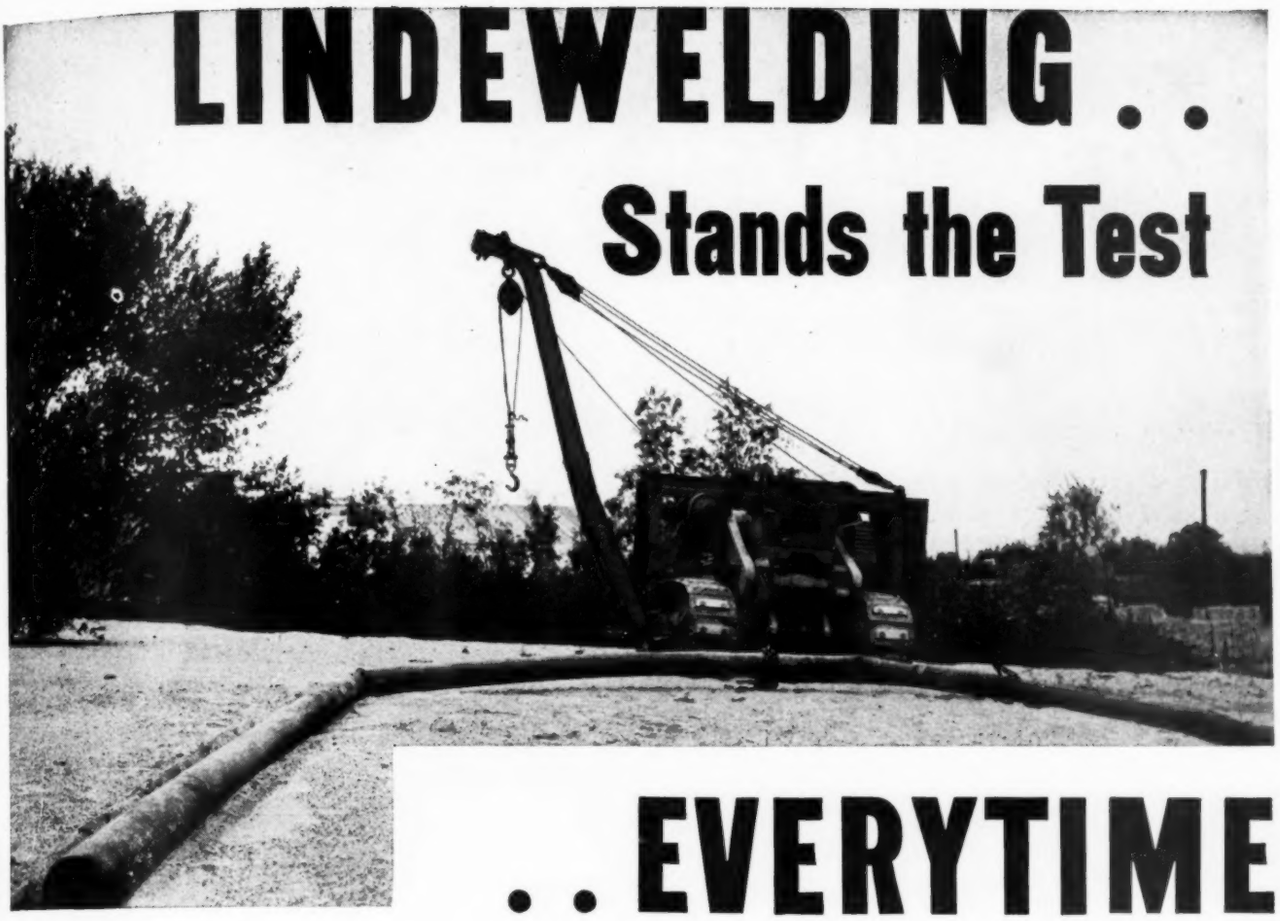

Loss Of Head In Feet Of Liquid
Flow Chart For Liquids
6 - In. Pipe - Inside Surface Clean
5.047 - In. Inside Dia.
Barrels Per Hour (42 Gallons)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Flow Chart For Liquids
6 - In. Pipe - Inside Surface Clean
6.065 - In. Inside Dia.
Barrels Per Hour (42 Gallons)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Barrels Per Hour (42 Gal.)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Kinematic Viscosity ft² / lb. Sec. Units
Viscosity Saybolt Seconds
Flow Chart For Liquids
8-in. Pipe - Inside Surface Clean
7.90-in. Inside Dia.
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)


Loss Of Head In Feet Of Liquid
Barrels Per Hour (42 Gal.)
Gallons Per Minute
Cubic Feet Per Minute
Velocity In Feet Per Second
Kinematic Viscosity ft² / lb. Sec. Units
Viscosity Saybolt Seconds
Flow Chart For Liquids
10-in. Pipe - Inside Surface Clean
10-in. Inside Diameter
Pressure Drop In Pounds Per Sq. In. Per Thousand Feet (Multiply By Specific Gravity)

LINDEWELDING . . Stands the Test



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Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XV

PHYSICAL PROPERTIES OF FRACTIONS OF PETROLEUM OIL (Continued)

GAS LAWS

TEMPERATURE, PRESSURE, AND VOLUME RELATIONS. A knowledge of the effect of temperature and pressure on the volume of gases is of vital importance in many computations. The effect of pressure is described by Boyle's Law, which states: At a constant temperature the volume of a gas is inversely proportional to the absolute pressure. In other words, if the pressure is high the volume is small and if the pressure is low the volume is great. The law may be stated mathematically as follows:

$P_1V_1 = P_2V_2$ (Boyle's Law)
P_1 = Original pressure (absolute)
V_1 = Volume at original pressure
P_2 = Final pressure (absolute)
V_2 = Volume at final pressure.

Example 15—Change of volume with pressure.

200 cu. ft. of gas is to be compressed from atmospheric pressure to 30 lb. per sq. in. gauge at a constant temperature. What is the new volume?

$P_1 = 14.7$ lb.
$P_2 = 30 + 14.7 = 44.7$ lb.
$V_1 = 200$
$V_2 = ?$

$$V_2 = \frac{P_1V_1}{P_2} = \frac{14.7 \times 200}{44.7} = 65.7 \text{ cu. ft.}$$

Other relations of a similar nature are:

At a constant pressure, the volume is directly proportional to the absolute temperature.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$ (Guy Lussac's or Charle's Law)

T_1 = original temperature in deg. fahr. absolute
T_2 = final temperature in deg. fahr. absolute.

At a constant volume, the relation between temperature and pressure is:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

And the combined equation for all these is:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Example 16—Change of volume with temperature.

200 cu. ft. of gas is to be heated from 100 deg. fahr. to 282 deg. fahr. at a constant pressure. What is the final volume?

$V_1 = 200$
$V_2 = ?$
$T_1 = 460 + 100 = 560$
$T_2 = 460 + 282 = 742$

$$V_2 = \frac{V_1T_2}{T_1} = 200 \times \frac{742}{560} = 265 \text{ cu. ft.}$$

Example 17—Volume of flue gas.

A flue gas consists of nitrogen, oxygen, carbon dioxide and water vapor and its molecular weight is 30. What is the volume of 100 lb. of this gas at 200 deg. fahr., and at a barometric pressure of 740 mm.?

What is the volume at 1000 deg. fahr.?

Basis: 100 lb. of gas.

Refer to Article XIV (*The Petroleum Engineer*, December, 1934).

$$\text{Mols of gas} = \frac{100}{30} = 3.33$$

Atmospheric pressure expressed in mm. is 760.

Volume at 60 deg. fahr. and 760 mm. $= 3.33 \times 379 =$ 1262 cu. ft.

Volume at 200 deg. fahr. and 760 mm. $=$

$$1262 \times \frac{(460 + 200)}{(460+60)} = 1603 \text{ cu. ft.}$$

Volume at 200 deg. fahr. and 740 mm. $=$

$$1603 \times \frac{760}{740} = 1647 \text{ cu. ft.}$$

The volume at 1000 deg. fahr. will be computed from the original data in a single operation.

Volume at 1000 deg. fahr. and 740 mm. $=$

$$\frac{100}{30} \times 379 \times \frac{1460}{520} \times \frac{760}{740} = 3640 \text{ cu. ft.}$$

Petroleum vapors such as those from gasoline or gas oil are not perfect gases and they do not behave exactly as the gases that were studied in Examples 15, 16 and 17. However, the above laws do apply with fair accuracy to petroleum vapors if the pressure does not exceed about 25 lb. per sq. in. and if the temperature of the vapor is more than 100 deg. fahr. higher than the boiling-point of the oil.

Nevertheless, no other simple relation between the volume, temperature and pressure of a gas is available, and hence refinery engineers normally use the above relations even though they are inaccurate. Brown, Souders and Smith[1] present methods by which the volume, temperature and pressure relations of hydrocarbon gases can be more accurately computed but the method that they suggest is inadequate for most refinery work and is too complicated to be discussed here.

THERMAL CONSTANTS

HEAT OF VAPORIZATION. The heat of vaporization or latent heat may be defined for our purposes as the B.t.u. required to vaporize a pound of liquid at its atmospheric boiling-point. If vaporization takes place at another temperature (or pressure) the latent heat is different from that at atmospheric pressure. The gravity of the oil also affects the latent heat. Fig. 34 is a chart of latent heat[2] plotted against boiling-point.

Example 18—Heat of vaporization.

1200 lb. of gasoline (60 A.P.I.) is to be vaporized at 300,

*Professor of Petroleum Refining, University of Tulsa.

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400 and 500 deg. fahrenheit. How much heat is required in each case?

The oil can be vaporized at these several temperatures by using different pressures. See Fig. 34.

Vaporizing at 300 deg. $1200 \times 113 = 135{,}800$ B.t.u.
Vaporizing at 400 deg. $1200 \times 101 = 121{,}000$ B.t.u.
Vaporizing at 500 deg. $1200 \times 89 = 106{,}900$ B.t.u. (approx.)

The latent heat varies because of the inherent differences in oil stocks, but approximate latent heats for commercial products when vaporized at a normal temperature, are:

Material	*Latent Heat B.t.u./lb.*
Gasoline	110 - 120
Kerosene	75 - 80
Gas Oil	55 - 65
Wax Distillate	50 - 55

SPECIFIC HEAT. Specific heat is defined as the B.t.u. required to heat one pound of material through a range of temperature of one deg. fahrenheit. It applies to solids, liquids or gases.

The heat that is required to raise the temperature of a material can be computed by multiplying the number of pounds by the temperature difference and by the specific heat, thus:

B.t.u. for simple heating = lb. (temp. diff.) specific heat.

The specific heats of petroleum oil and petroleum vapor are given in Figs. 35 and 36. The data for the charts were taken from the papers by Forsch and Whitman,[3] Weir and Eaton[4] and Bahlke and Kay.[5] In using these charts, the fact that the critical temperature may be exceeded should be borne in mind; also, cracking starts to take place at about 680 deg. fahr., and hence the specific heats above this temperature are only approximate.

Example 19—Heat required to raise temperature of oil.

A. How much heat is required to raise the temperature of 500 lb. of a 40-deg. A.P.I. oil from 100 to 600 deg. fahrenheit?

Specific heat at 100 (Fig. 35) - - - - 0.48
Specific heat at 600 (Fig. 35) - - - - 0.775
1.255

$$\text{Av. sp. ht. from 100 to 600} = \frac{1.255}{2} = 0.627$$

Or more simply, sp. ht. at 350 deg. = 0.627.

Heat required: 500 (600—100) $0.627 = 156{,}500$ B.t.u.

B. How much heat is required to raise the temperature of 1000 lb. of a 50 A.P.I. vapor from 400 to 600 deg. fahrenheit?

Specific heat at $\frac{400 + 600}{2}$ or 500 deg. is 0.586 (Fig. 36).

B.t.u. required: 1000 (600—400) $0.586 = 117{,}200$.

The total quantity of heat required to heat and vaporize an oil can be computed from Figs. 34, 35 and 36. Confusion often arises because the exact temperature at which vaporization occurs is seldom known. However, the temperature of vaporization is not of great importance because almost the same total heat is obtained if the specific heat and the latent heat are carefully determined from the charts. As an illustration, Example 20 shows the heat required when heating and vaporizing gasoline at three different temperatures.

Example 20—Total heat to heat and vaporize gasoline.

One pound of a 60 A.P.I. gasoline is to be heated from 100 to 600 deg. fahr. by allowing it to vaporize at 200, 300 and 400 deg. fahrenheit. How much heat is required in each case?

Vaporizing at 200 deg. fahrenheit:
Sp. ht. (Fig. 35) from 100 to 200 deg. = 0.548
Latent heat at 200 deg. (Fig. 34) = 126
Sp. ht. (Fig. 36) from 200 to 600 deg. = 0.542
B.t.u. when vaporizing at 200 = (200—100) .548 + 126 + (600—200) $0.542 = 398$ B.t.u.

At 300 deg. = (300—100) 0.58 + 113 + (600—300) $0.572 = 400$
At 400 deg. = (400—100) 0.61 + 101 + (600—400) $0.593 = 403$.

Thus, the heat required when vaporizing at 200, 300 and 400 deg. fahr. differs only by a total of five B.t.u. The inaccuracy is not even this great if more exact latent heats are used.

CONVERSION CONSTANTS. In solving plant problems many physical constants or conversion factors are necessary. There are so many of these that they cannot all be given, but Table 15 shows some of the most useful factors.

TABLE 15

Degrees centigrade absolute	Deg. cent. + 273
Degrees fahrenheit absolute	Deg. fahr. + 460
Degrees fahrenheit	[(Deg. cent. + 40) × 1.8] — 40
Degrees centigrade	[(Deg. fahr. + 40) ÷ 1.8] — 40
1 deg. cent. change in temperature	1.8 deg. fahr. change in temperature
1 atmosphere	760 mm. mercury
	29.92 inches mercury
	14.697 lb. per sq. in.
	34 ft. of water
1 lb. per sq. in.	2.31 ft. of water
	51.71 mm. mercury
1 lb. mol volume	379.4 cu.ft. at 60 deg. fah. and 760 mm.
	359 cu.ft. at 0 deg. cent. and 760 mm.
1 gram mol volume	22.41 liters at 0 deg. cent. and 760 mm.
Density of water at 60 deg. fahr.	8.328 lb. per gal.
	62.37 lb. per cu. ft.
1 cu. ft.	7.48 gal.
1 gallon	231 cu. in.
	3.786 liters = 3786 cc.
1 petroleum barrel	42 gal. (also 50)
1 bbl. per day-capacity	1.75 gal. per hr.
1 kilogram calorie (1000 calories)	3.968 B.t.u.
1 British thermal unit (B.t.u.)	777.5 ft. lb.
1 calorie per gram	1.8 B.t.u. per lb.

The following examples illustrate the use of these conversion constants and at the same time allow a more complete illustration of the use of the specific heat and latent heat. To make the physical data complete a table showing the relation of A.P.I. gravity, specific gravity and density in lb. per gal. should be included but this would require several pages. Such a table can be obtained from the Government Printing Office[6] at Washington, D. C., for a small fee. The

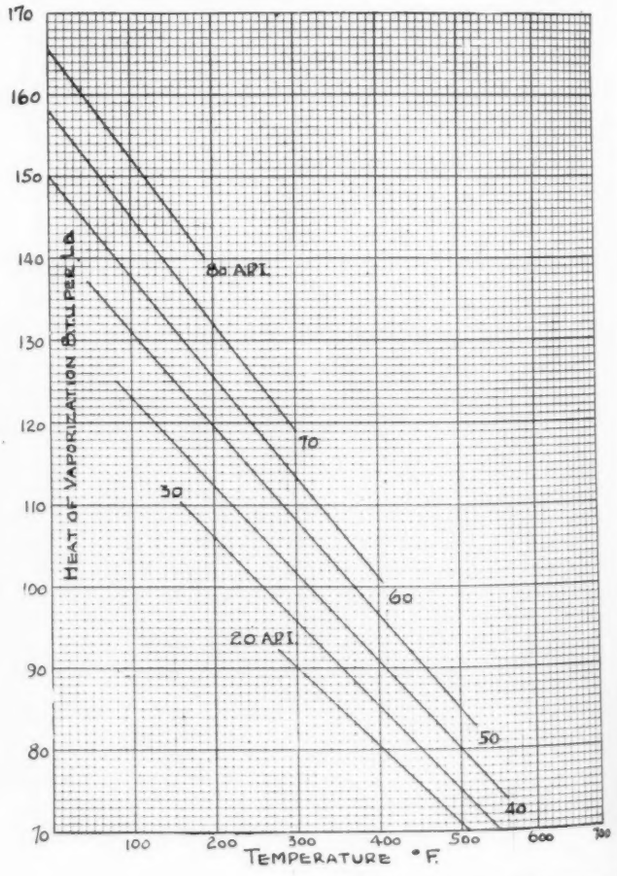

Fig. 34. Latent heat of petroleum oils

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This International Model C-55 Truck, 3½ to 4½-ton capacity, 190-in. wheelbase, recently went into service for the Magnolia Petroleum Company at Dallas, Texas, which now owns more than 300 Internationals. The C-55 is typical of the new series of beautiful streamlined Internationals.

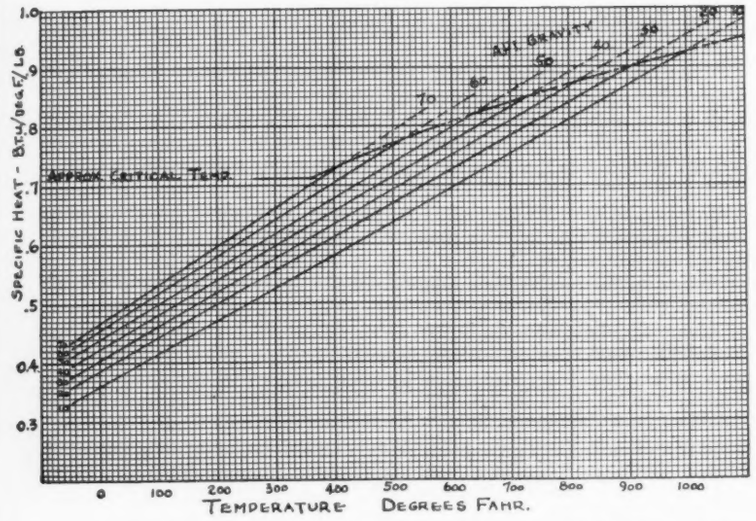

Fig. 35. Specific heat of liquid petroleum oils

equation relating A.P.I. and specific gravity that was given in Article XIV (December) can be used.

Example 21—Heat Required to Distill Crude Oil:

A crude oil is to be heated to 700 deg. fahr. in a pipestill. This temperature is sufficient to vaporize the gasoline, kerosene and gas oil. The yield and gravity of each product is as follows:

Material	A.P.I.	Per cent
Crude Oil	37	----
Gasoline	60	28
Kerosene	42	14
Gas Oil	33	26
Fuel Oil	?	32

The capacity of the plant is 4000 bbl. per day and the stock is available at 80 deg. fahrenheit.

How many B.t.u. must be absorbed per hour in the pipestill?

The gravity of the fuel oil is not given because it cannot be accurately determined from an evaluation analysis. The gravity will be computed by a material balance as follows:

	Per cent by liquid volume	Gal. per hr.	A.P.I.	Lb. per gal.	Total lb. per hr.	
Crude Oil	100	7000	37	6.993		48,900
Gasoline	28	1960	60	6.15	12,060	
Kerosene	14	980	42	6.79	6,650	
Gas Oil	26	1820	33	7.16	13,040	
					31,750	31,750
Fuel Oil	32	2240	?	?	.....	17,150

The weight of the fuel oil in lb. per gal. is:

$$\frac{17,150}{2,240} = 7.65 \text{ lb. per gal.}$$

$$\text{Sp. gr.} = \frac{7.65}{8.328} = 0.92$$

This corresponds to a gravity A.P.I. of 22.5 degrees.

The heat absorption in the pipestill is most easily handled by a tabulation (see below), but the heat for the gasoline will be computed separately as an illustration.

Heat for Gasoline:

Assume vaporization at 400 deg. fahr. Note that the assumption is not important. (Example 20).

Latent heat at 400 deg. - - - - - -	= 101	(Fig. 34)
Specific heat 80 to 400 - - - - - -	= .604	(Fig. 35)
Specific heat-vapor, 400-700 - - - -	= .618	(Fig. 36)
To heat liquid 12,060 (400-80) 0.604	= 2,325,000	
To vaporize 12,060 × 101	= 1,218,000	
To heat vapor 12,060 (700-400) 0.618	= 2,235,000	
Total heat for gasoline - - - - -	= 5,778,000 B.t.u.	

The following tabulation (Table 16) shows the same operations for the entire crude oil:

TABLE 16

Material	A.P.I.	Lb.	Vaporization at	Heat liquid deg.F.	Liquid sp.ht.	Heat vapor deg.F.	Vapor sp.ht.	L.H.	B.t.u.
Gasoline	60	12,060	400	80-400	.604	400-700	.618	101	5,778,000
Kerosene	42	6,650	500	80-500	.595	500-700	.63	81	3,035,000
Gas Oil	33	13,040	600	80-600	.604	600-700	.644	66	5,801,000
Fuel Oil	22.5	17,150	.....	80-700	.62	.....	.....	.....	6,590,000
Total B.t.u. required for crude oil									21,204,000

Example 22—Temperature of Mixture of Two Oils.

The feed stock to a cracking plant consists of 1000 bbl. of 26 A.P.I. gas oil at 500 deg. fahr. and 500 bbl. of 22 A.P.I. fuel oil at 100 deg. fahrenheit.

What is the temperature of the resultant mixture? Basis: one hour.

Weight of the two stocks:

	Gal. per hr.	A.P.I.	Lb. per gal.	Lb. per hr.
Gas Oil - - - - -	1750	26	7.48	13,080
Fuel Oil - - - - -	875	22	7.68	6,720
Mixture - - - - -	2625	----	.....	19,800

The heat that is lost by the gas oil will be absorbed by the fuel oil, thus:

$$13080\ (500-x) \text{ sp. ht.} = 6720\ (x-100) \text{ sp. ht.}$$

The equation must be solved by trial and error methods because the specific heats cannot be determined until the unknown temperature is found. The temperature will be approximately 367 deg. fahr. or two-thirds of the difference between 500 and 100 but the specific heat of the gas oil is higher than for the fuel oil and hence a temperature of 390 deg. will be the first assumption.

Assume x = 390 deg. fahr.

13080 (500-390) 0.65 = 935,000

6720 (390-100) 0.53 = 1,030,000

A lower temperature should be used.

Assume x = 380

13080 (500-380) 0.648 = 1,015,000

6720 (380-100) 0.526 = 990,000

The temperature is about 381 deg. fahrenheit. More accuracy than this is not justified.

QUESTIONS

1. One cu. ft. of gas is measured at 60 deg. fahr. and atmospheric pressure. If the temperature is raised to 580 deg. fahr. and the pressure to 14.7 lb. per sq. in gage, what will the volume be?
   Answer: 1.
2. Define latent and specific heat in the units that are used in the petroleum industry.
3. Convert 212 deg. fahr. to deg. centigrade.
   Answer: 100.
4. How many B.t.u. are required to raise the temperature of one pound of 40 A.P.I. oil from 300 deg. to 400 deg. fahrenheit?
   Answer: 62.7.
5. How much heat is required to vaporize the one lb. (Question 4) at 400 deg.?
   Answer: 91.

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[1] "Pressure-Volume-Temperature Relations . . . ," *Ind. Eng. Chem.* 24:513, 1932.

[2] Cragoe, "Thermal Properties of Petroleum Products," U. S. Bureau of Standards, Misc. Publication No. 97, 1929.

[3] *Ind. Eng. Chem.*, 18:795, 1926.

[4] *Ind. Eng. Chem.* 24:210, 1932.

[5] *Ind. Eng. Chem.*, 21:942, 1929.

[6] "National Petroleum Oil Tables," Table 5, U. S. Bureau of Standards Circular No. 154.

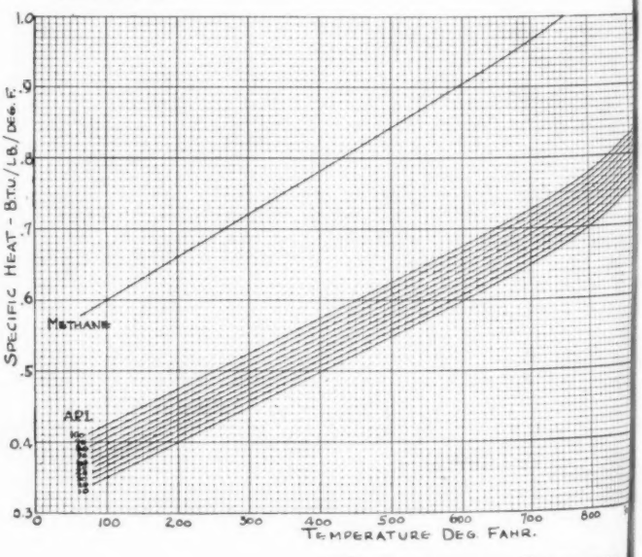
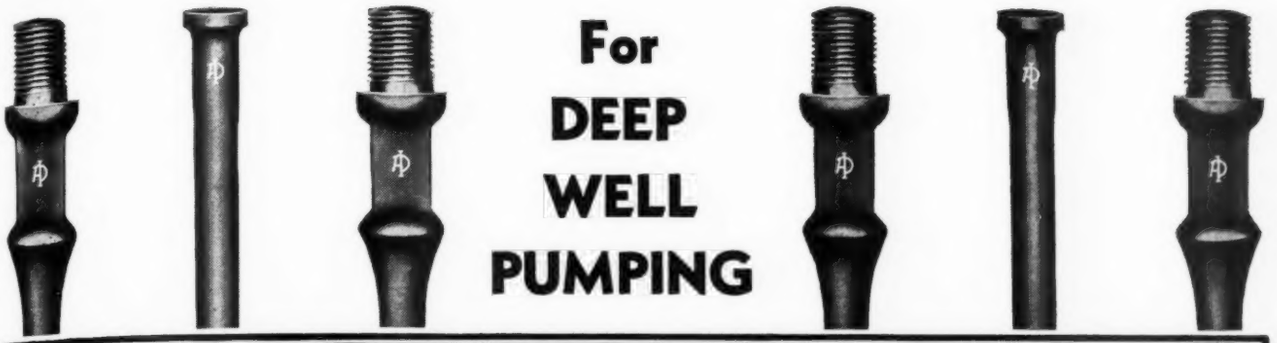


Fig. 36. Specific heat of petroleum vapor



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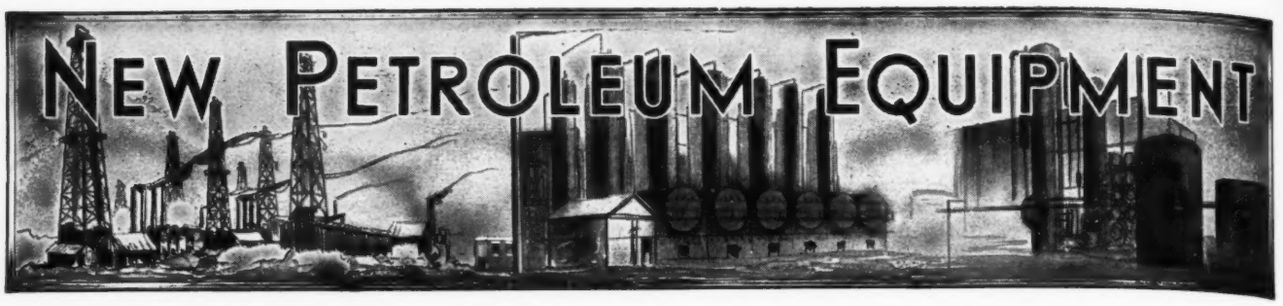
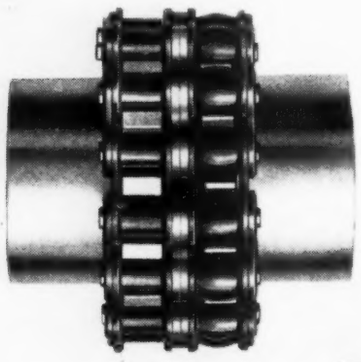


Baldwin-Duckworth Flexible Coupling

THE patented flexible chain coupling shown in the accompanying illustration has been designed by Baldwin-Duckworth engineers to provide for free operation without friction and excessive noise. This is accomplished by the use of special double width roller chains. One strand of the chain is equipped with the standard cylindrical rollers whereas the other strand has convex surface, oversize rollers that provide for free operations



where shaft deflection and misalignment exist. Permanent shaft deflections up to three degrees can be handled without undue strains, thus taking care of shaft joints with wabbles or permanent eccentricities.

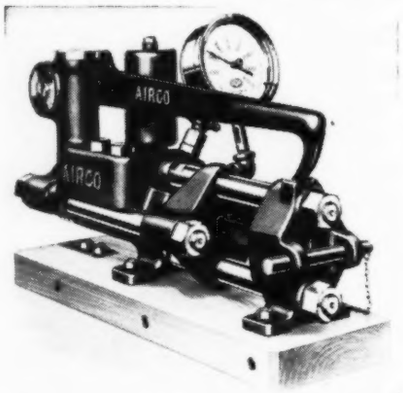
This Baldwin-Duckworth chain coupling does not obtain flexibility through "easy" or "sloppy" fits that result in friction and in premature wear unless perfectly lubricated by means of an oil-tight case, the manufacturer states. It is self-aligning and does not require the added cost of the oil-tight case or housing. It is efficient because the special heat-treated convex rollers operate freely on the hardened sprocket teeth without binding or undue wear.

Bulletin No. 55, descriptive of this full flexible chain coupling, as well as of the standard semi-flexible type, has been issued by the Baldwin-Duckworth Chain Corporation of Springfield, Mass., and copies are now available.

Portable Testing Machine for Welding Work

THE growing demand for accurate knowledge of weld strength is the natural result of great developments in welding. In fabrication and in pipe line work, engineers now consider it essential to know with close exactitude the actual strength of welds as they are made. Also knowledge that the welds are as strong as the plate being welded is frequently desired.

The delay and complexity of shipping weld specimens to testing laboratories have brought about a demand for a compact, accurate and portable testing machine for use right on the job. In answer to this demand the Air Reduction Sales



Company, New York City, has developed the Airco Portable Tensile and Bend Testing Machine, which is a compact, comparatively light machine that can be carried right to the welding job so that welded specimens can be tested on the spot, rapidly and easily.

The machine consists essentially of an oil pump, hydraulically actuated piston or ram, two heads—one fixed and one movable—for gripping the test specimens, and four symmetrically located steel shafts, two of which transmit the piston motion and load to the movable head. The other two shafts maintain the alignment of the two heads, and prevent the introduction of bending stresses in the tensile test specimen.

By means of a long lever attached to the pump, and the ratio between the areas of pump plunger and hydraulic ram, the downward force on the pump lever is magnified 400 times in the load applied to the test specimen. This magnification of the force applied to the pump lever, together with the large piston displacment of the oil pump, enables specimens to be tested rapidly and with a minimum of effort.

The load on the test specimen is indicated on a 6-in. pressure gauge of special construction, carefully calibrated against a standard dead-weight tester. The gauge is designed to maintain its accuracy under the strains of usage and shipping.

The machine is calibrated, using clean lubricating oils covering the range of viscosities sufficient to assure that the viscosity of the oil does not materially affect the accuracy of the machine. Any good light crank case oil can be used. The oil chamber is provided with a filter to prevent any dust particles that may drop into it from entering the oil passages.

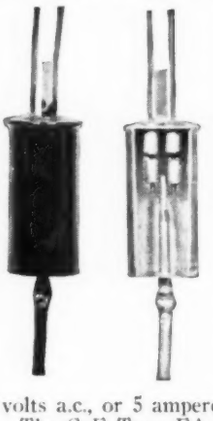
With a few strokes of the operating lever, after the specimen is set up, the operator of the Airco testing machine can apply a direct load up to 40,000 lb. to specimens from 9½ in. to 10 in. long, up to ½ in. thick, and up to 1½ in. wide. Then by using specimens of smaller cross-sectional areas than the maximum 1½ in. by ½ in., loads equivalent to 150,000 lb. per sq. in. or higher can be applied. The stroke of the movable head is up to 2¾ in., more than ample for practically any of the ferrous or non-ferrous metals. Readings are accurate to plus or minus two per cent.

For the bend test, the machine is provided with an anvil which fits into the movable head, and bends the specimen against a pair of supports set three in. apart and cast integral with the body of the machine.

The entire unit, machine and case, weighs only a little more than 200 lb. and can be handled freely without damage to the machine.

General Electric All-Metal Vacuum Switch

A NEW small vacuum switch, made almost entirely of steel and designed to take advantage of the absence of an arc when breaking a circuit in a high vacuum, has been announced by the General Electric Company, Schenectady, New York.



Although this new vacuum switch is only about ¾ in. in diameter and 1½ in. long and can be operated by a fraction of an ounce of pressure, it is capable of interrupting as much as five hp. as fast as 30 times a second. Designated as the Type FA-6 vacuum switch, this new device is rated at 10 amperes, 250 volts d.c. or 440 volts a.c., or 5 amperes at 500 volts d.c.

The G-E Type FA-6 vacuum switch is made of steel, hydrogen-copper-brazed and exhausted to a high vacuum through a hollow steel operating stem. This operating stem passes into the vacuum contact chamber through a thin steel end-wall whose flexibility permits the slight motion necessary for operation of the contact. The leading-in wires to the contacts are sealed in tiny glass beads inside small Fernico alloy thimbles which are inserted through the heavier opposite end-wall of the chamber. The Fernico-glass seal is a development of the General Electric Research Laboratory, and provides a sturdy and reliable gas-tight joint.

With this construction, the Type FA-6 vacuum switch can be used in almost any location, including those subject to severe shock and vibration. Constructional details are clearly shown in the illustration.

Closed Back Shovel Announced by Wood's Company

A NEW shovel has been announced by The Wood Shovel and Tool Company, Piqua, Ohio. This new shovel is known as the Wood's Closed Back, and, in many ways, resembles the familiar hollow-back type except that, instead of the usual hollow in the back of the blade, there is a steel plate welded securely to the blade and extending up into the socket. The upper part of the plate, however, is free to permit flexing and, since there is no strain on the insert, it cannot pull loose. By this construction the one-piece steel blade is made smooth both front and back, and yet permits the use of the tapered socket which, according to Wood's engineers, is heat-treated to provide greater strength and springiness than a heavy solid shank offers. Another advantage is that, with this type of socket, the lift or bend usually found only in plain-back shovels is in this new model.

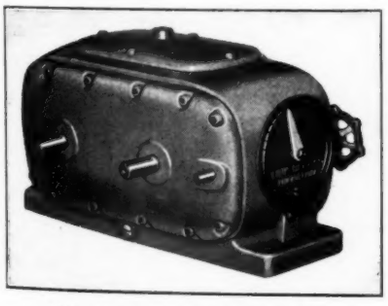
Other features in the Wood's Closed Back Shovel are the straight handle and turned shoulder. To replace a handle it is only necessary to push the new handle into position and replace two rivets. The turned shoulder consists of a lapping over of the metal at the top of the blade and the pressing of this double thickness of metal into a sturdy beading giving greater strength to the frog, eliminating blade splitting and providing greater foot comfort for workers.

An illustrated eight-page booklet on the new shovel has been prepared by the manufacturer. Copies may be obtained by writing The Wood Shovel and Tool Company, Piqua, Ohio.

Novel Variable Speed Transmission Announced

A NOVEL self-adjusting, positive variable-speed transmission for fractional hp. duty, known as the Link-Belt V. R. D. (Variable Roller Drive), is being announced by Link-Belt Company, Philadelphia and Chicago, as a companion to their P. I. V. gear variable-speed transmission announced about five years ago.

The V. R. D., which is capable of an output of ½ hp. at maximum speed, with a maximum ratio of speed variation of 10 to 1, continues such features as compact all-metal construction, total enclosure, self-lubrication in an oil bath, protection from moisture and grit, and the use of a chain for transmitting the power positively.



(Above) The new Link-Belt V.R.D. (Variable Roller Drive). Horizontal Type

Novelty in the V. R. D. consists in the construction and application of the chain that is used for transmitting the power from input to output shaft. It is side-contact roller chain, consisting of steel

(Below) A Section of Link-Belt V.R.D. Chain

links, made endless and connected by hardened steel pins in hardened steel joint bushings.

Openings in each pitch of links provide a pocket for each of two hard-steel rollers, and from both sides a portion of roller protrudes sufficiently to permit each pair of chain rollers, at each engagement of chain and wheels, to roll into contact with the hardened steel conical opposed disks forming the driver and driven wheels, until finally the chain is engaged positively in the wedge-shaped wheels at the proper pitch line for the speed desired on the output shaft. The disengagement of chain also is a smooth, rolling action.

A speed indicator permits ready check-up on operating speed settings. Spring pressure applied to the two disks of one wheel serves to maintain correct tension and compensate for natural chain wear automatically.

The V. R. D. is furnished with horizontal or vertical box, with or without reduction gearing, and also can be supplied motorized, with motor forming an integral part of the unit.

Lincoln Alternating Current Welder Announced

THE Lincoln Electric Company, Cleveland, Ohio, announces a new a-c. welder known as the Lincoln "Shield Arc AC." This welder is of the motor generator type, which takes 2-phase or 3-phase a.c. of standard voltages and frequencies and converts it into a.c. of lower voltage and at that higher frequency most suitable for arc welding with either heavily coated or washed electrodes in all positions. This principle, exponents of a-c. welding say, is an innovation that greatly enhances commercially the new type of machine.

The manufacturer points out the following features of the new equipment.

(a) Improved arc characteristics due to the higher frequency such as more stable arc, less magnetic blow, easier starting of arc.

(b) Improved weld metal since there is less spatter loss and in multiple pass welding greater density.

(c) Better power characteristics from the line. Since the machine takes power from all phases instead of from one phase, unbalancing of phases is eliminated and a power factor of approximately double that of the transformer type is obtained.

Since this type of welder draws from the line balanced power at lower amperage and higher power factor, the regulation of the transmission equipment is materially improved over that of the usual transformer type, the manufacturer states.

The new "Shield Arc AC" welder is built in portable and stationary a-c. motor-driven models in two sizes. The smaller capacity machine can be used for continuous welding with electrodes of $\frac{3}{32}$ in. to $\frac{1}{8}$ in. in size; the larger capacity welder handles electrodes from $\frac{1}{8}$ in. to $\frac{3}{8}$ in. in size. These machines are wired for 220, 440 or 550 volts a-c. supply, 2- or 3-phase, 50 and 60 cycles. In appearance, size and weight the "Shield Arc AC" is almost identical with its companion, the "Shield Arc" machine for d-c. welding.

The manufacturer also claims that, according to actual test, the current drawn from the line by this machine is no more than that drawn by the usual d-c. motor generator type.

Axelson Superservice Hardened Steel Grooved Plunger

AS quality companion to the Axelson Superservice Hardened Steel Liners, the Axelson Superservice Hardened Steel Grooved Plungers are now being offered to the trade by the Axelson Manufacturing Company, Los Angeles. It is claimed that many difficulties encountered in pumping from deep production zones can be successfully handled by the installation of these plungers.

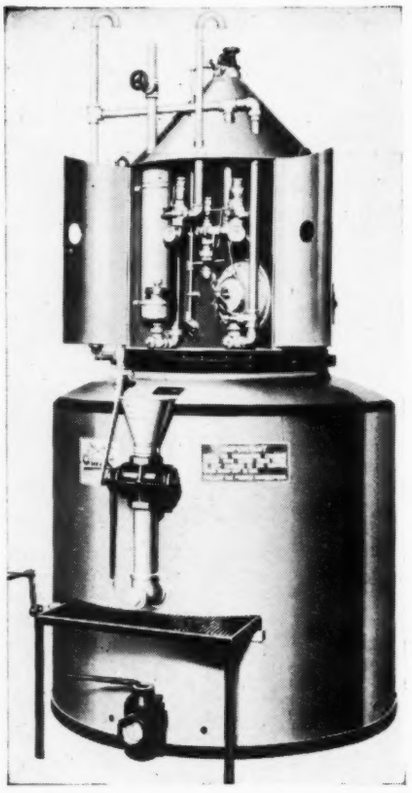
According to Axelson engineers, the plunger has been developed and manufactured as the result of a definite demand on the part of oil company production men and engineers, and in line with Axelson's progressive activities in oil field pumping equipment. A definite need for pump plunger equipment of a higher type, to be used in conjunction with the improved Axelson liners, had been expressed, and after careful study and research, the Axelson Manufacturing Company offer this special molybdenum nickel analysis steel treated under automatically recorded and controlled temperature equipment. Reports on these plungers to date, from both the California and Mid-Continent fields, indicate that they are giving maximum satisfaction, it is stated.

The Axelson Hardened Steel Grooved Plungers incorporate a series of grooves that, it is claimed, materially reduce the friction, increase production, and improve the sealing effect of the fluid between liners and plungers. These plungers are made to the diameters required for rod and tubing sectional liner-type pumps.

Stationary Oxweld Generator

THE Linde Air Products Company, 30 East 42nd Street, New York, N. Y., has just announced another important addition to its acetylene generating equipment. This new automatic stationary generator, known as the Oxweld Type MP-5, is rated to deliver 1,000 cu. ft. of acetylene per hour. It is listed by the Underwriters' Laboratories, Inc. Its advent should be of interest to users who want high capacity without operating two or more generators simultaneously.

In general appearance it resembles the Oxweld Type MP-4 portable generator, recently announced, with which it is identical in principle, except for size and slight changes to make it suitable for stationary use.



Its compactness and efficiency show intelligent design in every detail. The feed is of the gravity type. The mechanism is of a most advanced design. The feed control unit is self-contained and is bolted to the inside of the carbide hopper. The feed valve unit is actuated by a diaphragm. Pressure on the diaphragm is exerted by a housed and loaded spring unit. The spring is encased in a small housing and set at the factory to deliver about 13 lb. per sq. in. pressure. This can be changed within a range of about 2 lb. per sq. in. by an external adjustment. The set pressure feature does away with the necessity of setting the pressure when the machine is started. The pressure variation within the generator is not more than ¾ lb., and this variation is nullified in the service line by the built-in Oxweld Type R-57 Regulator.

The carbide-charging door, the water-filling opening, the residue valve, and the handhole have been built on generous proportions so that time can be saved in emptying, recharging and inspecting. The carbide hopper affords the greatest operating efficiency combined with easy cleaning; and the regulator filter unit, with its large capacity pads, is within easy reach inside the handhole.

Instead of having an external hose connection manifold, it has the service valve which is necessary on a stationary machine on the service pipe that leads directly from the back-pressure valve.

A funnel and a 3-in. lubricated water-filling valve and vent cock take the place of a water-filling cap and overflow plug. The water-filling valve has an interference rod that operates the vent cock on a pipe leading to the outdoor vent line. This system makes it impossible to add water unless the cock is open to allow for the displacement of gas.

The relief valve arrangement on the Type MP-5 generator is particularly interesting. A separate relief valve with a separate outdoor vent line is provided for the back-pressure valve, and two other relief valves with a common outdoor vent line are provided for the generator chamber. Two relief valves are used because of the high capacity of the generator, and also because it is easier to get good seating and prevent leakage when two valves are used instead of one large one.

The Oxweld Type MP-5 acetylene generator is provided with a hopper that has eyelets around the top so that it can be removed with a block and tackle. Since a charging platform is usually built alongside a stationary generator, none has been provided on the new generator.

To insure a gas-tight seal and to lessen slaking when the generator is out of service for long periods, a soft rubber seat is provided on the hopper outlet.

The hydraulic back-pressure valve and the reservoir are combined in one shell. The reservoir protects against accidental loss of water from the backpressure valve and prevents water from backing into the regulator. An intermediate valve on one side of the hydraulic back-pressure valve and the service valve on the other make it possible to check the water level without escaping gas or loss of water.

Fisher Cycle Regulator

THE Fisher Governor Company, Marshalltown, Iowa, has announced the new Fisher Cycle Regulator. This cycle or intermittent flow controller has been developed for controlling the input high

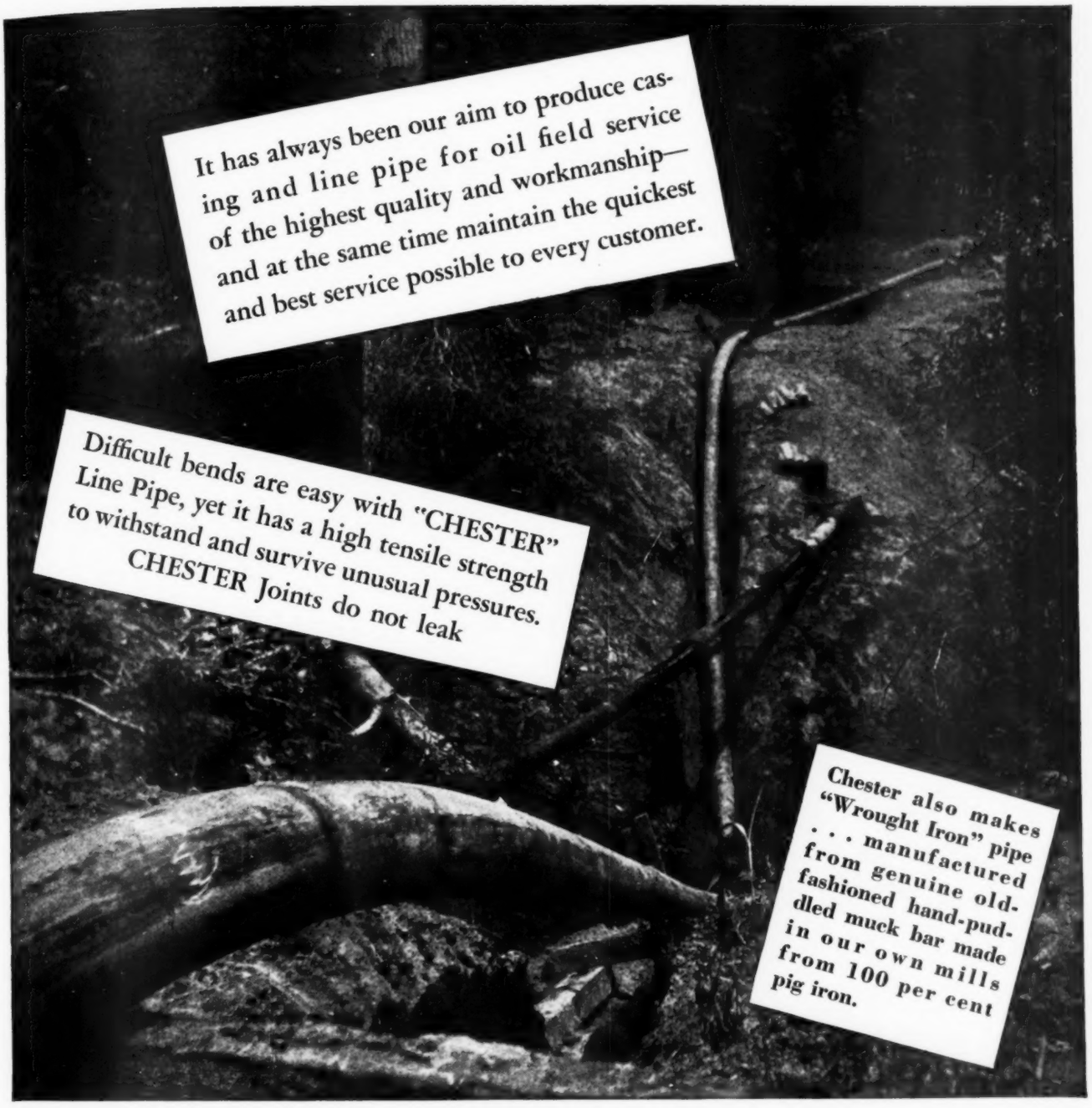
pressure gas to oil wells being flowed with the intermittent gas lift system. Many outstanding construction features are included in this new controller which has been fully proved by numerous installations in the Oklahoma City field.

The main valve consists of a single seated steel body, sizes 1 in. to 2 in., inclusive, for pressures up to 1,000 pounds. This valve is diaphragm controlled and actuated by a clock, cam, and pilot valve.

The clock and pilot mechanism is mounted as an integral part of the upper diaphragm casing. Weather-proof cover is easily removed to allow inspection or changing of cam setting. The 24-hour clock is wound through a plugged opening in the cover. Clocks with cams for one complete rotation in 1, 6 or 24 hours are available. Cam notches which govern the frequency of the input gas are cut on the job after installation is made.

The accompanying illustration shows

(Continued on Page 72)


It has always been our aim to produce casing and line pipe for oil field service of the highest quality and workmanship—and at the same time maintain the quickest and best service possible to every customer.
Difficult bends are easy with "CHESTER" Line Pipe, yet it has a high tensile strength to withstand and survive unusual pressures. CHESTER Joints do not leak
Chester also makes "Wrought Iron" pipe . . . manufactured from genuine old-fashioned hand-puddled muck bar made in our own mills from 100 per cent pig iron.

SOUTH CHESTER TUBE COMPANY, Chester, Pa.

District Sales Managers

W. E. Gibson, 801 Columbia Bank Bldg., Pittsburgh, Pa.
H. A. Morse, 30 Church St., New York, N. Y.
J. P. Cooney, 715-716 A. G. Bartlett Bldg., Los Angeles, Calif.
J. P. Steele, 603 Petroleum Bldg., Ft. Worth, Texas.

District Offices

J. D. Swartz, 1231 S. Evanston St., Tulsa, Oklahoma.
E. L. Moseley, 2218 Mills St., Houston, Texas.
Burt S. Shafer, Southwest Representative, 4313 Fairfax Ave., Dallas, Texas, or 603 Petroleum Bldg., Ft. Worth, Texas.

District Warehouses

Houston, Texas; Thenard, Calif.; San Francisco, Calif.

Distributors

United Pipe & Supply Corp., Charleston, Danville, West Hamlin, W. Va.; Paintsville, Ashland, Allen, Prestonburg, Ky.
Prichard Supply Co., Mannington, W. Va.; Mather and Waynesburg, Pa.
LeValley, McLeod, Kinkaid Co., Inc., Elmira and Olean, N. Y.
Kane Supply Company, Kane, Lawrenceville, Brookville, Pennsylvania.
Bovaird & Co., Bradford, Pa.
Western Supply Company, Tulsa and Oklahoma City, Okla.; Dallas, Houston, Pampa and Willow Springs, Texas.
Star Drilling Machine Co., 550 Clinton St., Portland, Ore., and Akron, Ohio.
Stephen H. McCabe, 508 4th St., San Francisco, Calif.
Barde Steel Company, Seattle, Wash., and Portland, Ore.
Louisiana Supply Co., Sulphur and Brimstone, La.
Dunigan Tool and Supply Co., Main Office, Breckenridge, Tex. Branch stores, Willow Springs, Pampa, Turnertown and McCamey, Tex., and Hobbs, N. M.
Okmulgee Supply Corporation, Okmulgee, Okla.
Oil Field Equipment Co., San Antonio, Texas.

CHESTER

LINE PIPE AND STEEL CASING

(Continued from Page 70)
the complete FISHER Type No. 4655 Cycle Regulator and an interior view of the clock and pilot mechanism.

Fisher Governor Company, Marshalltown, Iowa, have just published a complete bulletin describing this new controller. Request Bulletin No. 80-B.

The "Cardwell Allsteel" Mast-Tra-Puller

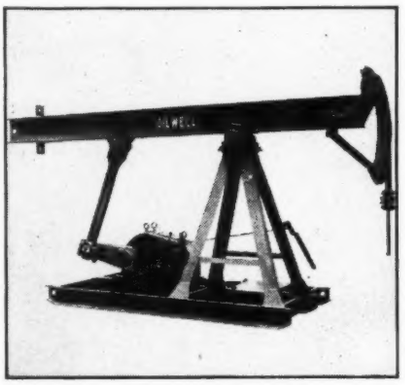
THE Allsteel Products Manufacturing Company, Wichita, Kansas, is now offering under its trade mark, "CARDWELL ALLSTEEL," a new oil-well servicing unit, the "Mast-Tra-Puller," a sturdy, portable unit built for pulling rods and tubing from 2-in. tubed wells having a maximum depth of 3000 ft., where not equipped with a derrick. This is a pulling mechine mounted on a 2-wheel trailer carrying its own power plant. It is easily transported over the roughest country and can be moved to any location accessible to a truck and at the average speed a truck is driven, 30 or 40 miles per hour.

At the well it is easily erected with its own power lifting device, requiring but a few moments to put in use as a pulling, bailing, or swabbing unit, releasing the truck for other work.

The telescoping mast, equipped with a 3-sheave, all-metal crown block having line guards to keep the lines on the sheaves, can be extended to a height of 40½ feet.

"Oilwell" No. 10 Pumping Unit

THE Oil Well Supply Company of Dallas, Texas, recently added the "Oilwell" No. 10 to its line of structural-steel floor-type pumping units. The "Oil-



well" No. 10, which is recommended for a maximum polished rod load of 10,000-lb. (A.P.I. rating), is a single crank unit and is similar in appearance and general construction to the company's larger ODH-18 pumping unit.

The base and derrick-type samson post are of strong and rigid structural-steel arc-welded construction. The walking beam is a sturdy CB-beam reinforced with welded stiffener plates. The pitman is a strong I-beam with cast-steel bearing connections welded to each end. Plate-type counterweights are furnished for the extension at the pitman end of the walking beam. The polished rod hangar is a semi-steel mulehead equipped with a 1-in. non-spinning cable, assuring a straight polished rod motion. Ample clearance for servicing a well is provided, when the crank is in its lowest position, by removing the top pin from the mulehead and suspending it from its braces.

All the bearings are designed for heavy-duty service and long life. The two saddle bearings and the upper pitman bearing are fully-enclosed, oil-bath and bronze-bushed. They are equipped with oil seals which make them oil-tight and weather-proof. The wrist-pin bearing is a heavy-duty straight roller bearing with hardened-and-ground inner and outer sleeves and rollers. It is grease-packed and fully-enclosed in a weather-proof self-aligning housing.

The speed reducer is a Westinghouse - Nuttall ODH-110 double reduction gear with an overall reduction of 32:1 and an industrial rating (Lewis formula) of 30 hp. at 20 strokes per minute. It is conservatively rated for oil field service, 10 hp. at 20 strokes per minute. The gears are of the single-helical type and are fully heat-treated for the best wear characteristics and the greatest strength. The teeth are of long and short addendum form and are accurately cut by the hobbing process after heat-treatment to assure good tooth contact.

Heavy-duty Timken roller bearings are used exclusively in this speed reducer. The gears dip into the oilbath, which is fully enclosed in the heavily-reinforced weather-proof housing. The splash from the gears flows continuously through troughs to the bearings, thus providing positive and ample lubrication.

The crankshaft has three keyways cut 120 deg. apart, permitting the crank to be mounted in three different positions for equalizing the wear on the low-speed gear train. The hub of the crank is split so that it can be installed and removed with ease. Three wrist-pin holes provide stroke lengths of 22½ in., 30 in., and 37½ inches. A brake, which is controlled from the samson post, is provided on the high-speed shaft of the speed reducer, making it possible to stop and hold the crank easily in any desired position.

The "Oilwell" No. 10 pumping unit can be driven by a multi-cylinder engine or by an electric motor. The recommended maximum prime mover horsepower at 20 s.p.m. is 15. The recommended maximum pumping speed is 22 strokes per minute. The complete unit (less counterweights) weighs 4300 pounds.

The walking beam is drilled for the application of the "Oilwell" second-well pumping attachment which is furnished as optional equipment. This attachment consists of an "Oilwell" No. 12 jack pull-rod frame complete with bearing and strap. Pull rods are extended from the strap to a pumping jack at a second well. By means of this attachment, two wells are pumped by one prime mover and one pumping unit.

E. C. & M. Weatherproof and Dust-Tight Type A Safety Switches

A NEW line of weatherproof, dust-tight, Type A safety switches in standard sizes from 30 amperes to 600 amperes capacity, is now being supplied by The Electric Controller and Manufacturing Company, 2708 East 79th Street, Cleveland, Ohio. These switches use the same switch mechanism that is furnished with the standard E. C. & M. safety switch of Type A construction and should not be confused with the Type C safety

switches using lighter construction and which do not have safety interlocks.

These E. C. & M. weatherproof safety switches are equipped with fully interlocked door, making it impossible to operate the switch with the door open, or to open the door with the switch closed. They are enclosed in a 10-gauge steel cabinet that has been rust-proofed by Bonderizing before the enamel is applied. A heavy sponge rubber gasket makes a tight seal between the door and cabinet.

Features of these safety switches are compactness, narrow width, light weight (due to steel, most weatherproof safety switches are enclosed in cast iron enclosures), semi-floating, double break V-blades, V-stationary contacts backed up with steel springs that guarantee full contact under heavy pressure.

Four Wheel Drive Auto Company Brings Out High Speed Truck

COMBINING beauty and graceful lines with the high hp. used in their entire line of trucks, The Four Wheel Drive Auto Company of Clintonville, Wisconsin, has developed a new ton-and-a-half speed truck which they designate as Model HS. The company's engineers have directed special attention to speed, sturdiness, ease of steering, smoothness of riding, reliability, and safety on the road.

The specifications call for a road speed of 47 miles per hour, with full load.

The new model is propelled by an 84-hp. engine that develops 185 ft-lb. torque. The fundamental principle of applying power equally to all four wheels, used in all previous models of the Four Wheel Drive Auto Company's line, is retained in the new model HS. Ease of steering and simple handling is increased by setting the front axle back 42½ in. from the front bumper. The HS model employs this setback-of-front-axle principle also to obtain equal distribution of load.

This new entry in the truck field is built for heavy duty as well as fast traveling. The 6.50-20 tires are dual in the rear. The HS model's net mechanical rating is 88.2 per cent.

Stripping Non-Adjustable Roller Bearings

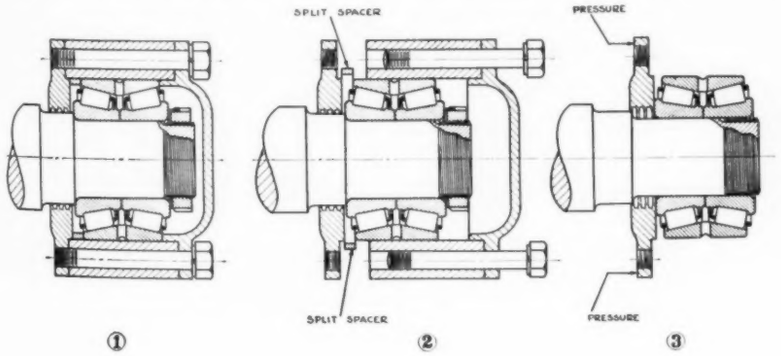
IN the NA type Timken Bearing, a non-adjustable unit designed by the Timken Roller Bearing Company, Canton, Ohio, especially for applications where it is not desirable to provide means for bearing adjustment in service, or where operating conditions require a fixed mounting at one end of an assembly and a certain amount of "Float" at the other, certain fits must be observed in order to obtain the proper running clearance, which is established at the time of manufacture. Fitting practice varies from .0005-.0015 in. tight for live shaft applications with .0000-.0020 in. loose fit in the housing for small shafts, up to .0060-.0100 in. tight and .0020-.0060 in. loose, respectively, in the case of 16-in. shafts.

In Fig. 1 a two-row bearing of this type is shown mounted in a solid housing. The cones are pressed in place with a tight fit, the inner cone seating against a shoulder on the shaft. The abutting cone faces are ground at the factory to provide the proper running clearance. The cup is located in the assembly by means of a split spacer ring on the inner end and a follower on the cover plate on the outer closure, as shown in the illustration.

This type of bearing is easily and quickly removed from the housing and shaft for inspection or salvage if pressure is applied only to the cone surfaces. Should pressure be applied through the cup, the resultant forces acting through the rollers, due to their tapered construction would tend to hold the bearing in place and it would take approximately three times as much pressure to remove the bearing as is required when pressure is applied only through the cones.

Fig. 2 illustrates the first step in removing a bearing of this type. When the through bolts are loosened the outer cover plate and bearing housing may be stripped off easily. This releases the split spacer ring that locates the bearing at the inner end.

The lock nut and tongued washer which clamp the cone to the shaft are next removed (Fig. 2), and when the split spacer ring is taken off, the inner closure plate may be brought forward, contacting the inner face of the inner cone. As both cones are in contact, continued application of pressure on the inner closure plate will slide the entire bearing assembly off the shaft smoothly and with a minimum of force (Fig. 3). No pressure will be transmitted through the cup and rollers as the bearing has a definite amount of running clearance.



The CAVINS Saves Time on Cleanout and Fishing Jobs

The CAVINS is the FASTEST as well as the most efficient method of cleaning out wells and fishing for junk. You can run it as soon as the tubing is pulled. No rigging-up or spudding. It operates at high speed and brings out load after load as fast as you can run in and pull out. Allow three seconds for loading on bottom. Ordinarily you will have the hole cleaned out in less time than it takes to get other methods in operation.

It is unexcelled in speed and efficiency as a fishing tool, when used with a junk trap or basket attached to bottom, for recovering such fish as pins, cones, discs, cuttings, rubber, etc.

It's the Best Way

If you haven't used The Cavins, or seen it used, write at once for descriptive Bulletin. It will save time, labor and money on clean-out and fishing jobs; and may be the means of saving the well in a crisis.

THE CAVINS CO.
2853 Cherry Ave. Long Beach, Calif., U.S.A.
Cable Address: "Cavins, Long Beach"
R. J. EICHE, *Foreign Representative*
Branches at:
Taft, Bakersfield, Goleta, and Santa Paula, Calif.
CAVINS CLEANOUT SERVICE:
Oklahoma City, Okla., and Wichita, Kansas
CAVINS BAILER SERVICE:
Houston and Kilgore, Texas, and Shreveport, La.

O. E. McCLATCHEY, purchasing agent for the Barnsdall companies, who was injured recently while hunting in Arkansas, is convalescing.

O. T. DAWSON, following a month's absence, has returned to his duties as manager of the Tulsa, Oklahoma, office of the National Supply Company.

HOWARD F. STOVER, purchasing agent of the Gaso Pump and Burner Manufacturing Company, Tulsa, Oklahoma, has been elected president of the Purchasing Agents' Association of Tulsa.

J. HOWARD PEW, president of the Sun Oil Company, Philadelphia, has been made chairman of the central committee on tanker and barge transportation of the American Petroleum Institute, a committee ordered created at the recent Dallas convention.

WILLIAM J. McKEE, manager of sales for the National Tube Company, and Miss Frances Garden Carr of Chicago, were married recently.

E. B. REESER, Tulsa, president of the Barnsdall Corporation, recently completed a business trip through the East.

V. A. CLANTON, field engineer for the Pennsylvania Refining Company of Bradford, Pennsylvania, recently was in Dallas, Texas, on business.

A. D. OTTO has been appointed assistant manager of stores for the Midwest division of the Oil Well Supply Company and has moved to Dallas from Houston, where he was district manager of the company's Gulf Coast district.

J. P. RAYZOR, formerly with the Shasta Oil Company at Wichita Falls, Texas, now has his own company, known as the Solo Oil Company. Headquarters are in the Harvey Snider Building, Wichita Falls.

The Oil Well Supply Company announces that Charles L. Lockett, Jr., has accepted a position in its export department, New York City. Mr. Lockett is widely known throughout the oil industry and has spent many years in foreign service.

J. D. COLLETT, president of O'Keefe & Collett Corporation, Fort Worth, Texas, has been made chairman of the Planning and Coördination Committee under the Petroleum Code to succeed Amos L. Beaty, who resigned, effective December 22nd.

Mr. Collett was born at Galveston, Texas, March 10, 1869, and moved to Fort Worth in 1890. His first operations in oil were at Spindletop in 1901, and he has been connected with the industry since, operating mostly in North and West Texas.

At present he is president of the Mid-Continent Oil and Gas Association, a director of the American Petroleum Institute, a member of the P. and C. committee, and since the effective date of the Petroleum Code has been general chairman of Region No. 4, comprising the states of Kansas, New Mexico, Oklahoma, and Texas.

He was the organizer of O'Keefe & Collett Corporation, of which he is president, and, in addition, operates individually as a producer.

HARRY H. DANSBOE, formerly electrical engineer with the Atlantic Oil Producing Company and now sales engineer with the Beckett Electric Company of Dallas, Texas, recently returned from an extended business trip in Mexico.

GEORGE H. COXON, head of the refining and technical departments of the Anglo-Persian Oil Company, recently made an inspection trip to Persia.

C. I. KELLY has resigned as chief chemist for the Anglo-American Oil Company, and has been made chief chemist of Herbert Green & Company, a new concern that is erecting a Duo-Sol lubricating oil plant in Lincolnshire, England.

C. D. ALWORTH has been placed in charge of the Standard Oil Company's Venezuela's Quiriquire field as superintendent. He succeeds J. G. Nations, who is now superintendent of the Cumarobo field for the Standard.

RALPH H. CHRISTY has been appointed manager of the Gulf Coast district of the Oil Well Supply Company. Norman E. Giles succeeds Mr. Christy as manager of the company's Houston store.

J. A. McCUTCHIN has been made district exploitation engineer at Pampa, Texas, for the Shell Petroleum Corporation to succeed S. F. Bolby, who is leaving for The Hague. McCutchin has been exploitation engineer for the Shell at the Tulsa office of the company.

CARL W. VOGT of Houston, Texas, Mid-Continent and Gulf Coast manager of the Shaffer Tool Works, Brea, California, and Miss Myrtle Jones, secretary and office manager of the company, were married on December 4. A wedding supper and dance was given in their honor by Mr. and Mrs. E. G. Lenzner, general manager of the Oil Equipment and Engineering Exposition, at the home of Chase E. Sutton, branch manager of the Pure Oil Company.

CARL W. VOGT

The bride and groom sailed December 11 aboard the S. S. General von Steuben for a three months' European tour. Mr. Vogt also will make business calls for the Shaffer Tool Works in London, The Hague, Germany, Roumania, and other European countries.

W. K. Whiteford Goes With British American

W. K. WHITEFORD

W. K. Whiteford, general manager and vice-president in charge of production for the Barnsdall Corporation, Tulsa, Oklahoma, resigned effective January 1st to become executive vice-president of the British American Oil Producing Company and the Toronto Pipe Line Company.

Whiteford joined the Barnsdall organization in California in 1924. In 1927 he was transferred to Oklahoma and in 1932 advanced to the position of vice-president in charge of production. In his new position he will continue to make his home in Tulsa.

New Committee Members Southwestern Gas Measurement Short Course

New members of the general committee for the 1935 Southwestern Gas Measurement Short Course are B. P. Stockwell of the Corporation Commission, Oklahoma City; William F. Lowe of Tulsa, secretary of Natural Gasoline Association of America; J. H. Satterwhite, Tulsa, American Meter Company; Earl Kightlinger, Shreveport, Louisiana, Arkansas Natural Gas Corporation; D. C. Williams, of Ponca City, Oklahoma, general chairman. John H. Baxter of the Inland Gas Company, Ashland, Kentucky, who was identified actively with the short course during the first two years of its history, was added to the ex-officio membership comprised of past general chairmen.

Chairmen of sub-committees are the following: Banquet, entertainment and arrangements, W. H. Carson, Norman, Oklahoma; program, R. D. Turner, Tulsa, Oklahoma; exhibits, G. W. McCollough, Bartlesville, Oklahoma; registration, E. F. McKay, Oklahoma City; study of practical methods, Ray Roundtree, Houston, Texas; and publications, Max Watson, Amarillo, Texas.

Ted Wirth With A. M. Byers Company

Ted B. Wirth, well known in the oil industry, has become associated with the A. M. Byers Company of Pittsburgh, Pennsylvania, and on February 1 will assume his duties as sales representative in Texas and Louisiana, working out of the Houston office.

Simpson Sand Wells Shut Down in Oklahoma City Field

Simpson sand wells in the Oklahoma City field have been shut down on account of a shortage of gas for lifting purposes, and, as under existing conditions with a large percentage of water produced the ordinary methods of production cannot be economically used, it appears that these wells must be produced on Reda pumps if produced at all, states a communication from A. Arutunoff, of the Reda Pump Company, Bartlesville, Oklahoma.

Recently a 150-stage, type "S," 97½-hp. Reda unit was installed in the Indian Territory Illuminating Oil Company's L. Trosper No. 1 well in the N. W. 12-11-3 of the Oklahoma City field. Although many pumps are in use in the field, all have been installed in Wilcox sand wells, but this unit is in a well producing from the Johnson sand and is making 1000 bbl. of fluid per day from 5700 feet. This well has 6⅝-in. casing.

AXELSON

PUMPS AND

SUCKER RODS

HAVE BEEN

PROVEN

by

Three

Generations

of

OilOperators

THE AMERICAN PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER

NRA U.S. CODE PETROLEUM EQUIPMENT

AXELSON MANUFACTURING CO.

P. O. Box 710, Vernon Station, Los Angeles

St. Louis 50 Church St., New York Tulsa

Mid-Continent and Eastern Distributor:
Frick-Reid Supply Corporation

Rocky Mountain Distributor:
Great Northern Tool & Supply Company

Book Reviews

Diesel Engineering Handbook (Seventh Edition). Published by Business Journals, Inc., 192 Lexington Avenue, New York City. L. H. Morrison, editor; T. A. Burdick, associate editor. Three hundred and twenty pages. Price $5.00.

The Diesel Engineering Handbook (formerly the Diesel Power Plant Handbook) is, as its name implies, a volume of reference for those concerned with the engineering aspects of Diesel engines. Among those who will find its pages valuable are engine builders, accessory manufacturers, engine purchasers, consulting engineers, and plant operators.

With the increase in demand for Diesel power within recent years has come an expansion in the equipment available. New engine designs, new accessories, and better installation and operating ideas have developed. With a view to giving the latest information on these subjects the Diesel Engineering Handbook has been written.

* * *

The Petroleum Register (1934-35 Edition). Published by the Petroleum Register Corporation, 165 Broadway, New York City. Seven hundred and twenty-four pages. Price $10.00.

The sixteenth annual edition of the Petroleum Register, giving detailed information concerning 23,000 oil companies, as well as other data of value to those connected with the petroleum industry in various capacities, has just come off the press. The volume this year shows an increase in size, containing 724 pages, 267 pages more than that of a year ago. Many new features have been added, including the Petroleum Code published in annotated form, an organization chart showing the personnel of the Planning and Coödination Committee, Sub-Committee, etc., a registry of tank vessels, an exporters' section, a section listing the names of refineries and their superintendents, and an enlarged statistical section in which is included several tables pertaining to gasoline.

Those in the industry who have used the volume in past years are acquainted with its value, a worth that should be enhanced appreciably in the latest issue because of its enlarged size and scope.

Dudley W. Moore is Southwestern representative for the Petroleum Register Corporation, making his headquarters in Tulsa, Oklahoma.

* * *

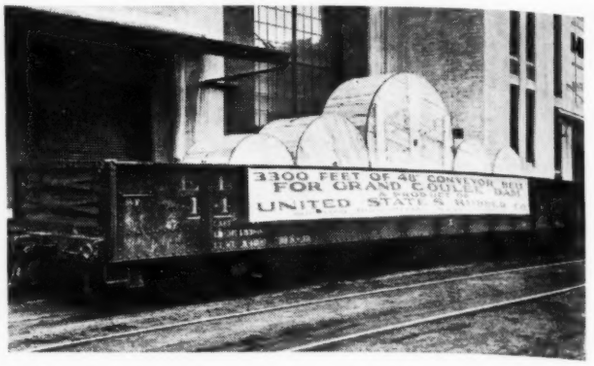
The Accounts of an Oil Company. By H. G. Humphreys, associate, American Institute of Accountants; certified public accountant (Oklahoma). American Institute Publishing Company, Inc., New York City (1934), 136 pp., numerous tables. Price $2.00.

The committee on publication of the American Institute of Accountants has selected this volume as one of its principal titles for the current year. In it Mr. Humphreys discusses with clarity the knowledge required and the procedure to be followed in auditing the accounts of an oil company. Since great changes have taken place in the methods of producing and refining petroleum, with a concomitant change in the methods of accounting, the committee of the American Institute of Accountants was of the belief that this vast industry required a comprehensive and modern discussion of the fundamental problems. Hence this volume.

The following chapter headings will give an idea of the scope of the volume: "Balance-sheet and General Accounts," "Departmental Investment and Income," "Forecast of Income," "Oil and Gas Properties," "Natural Gasoline Department," "Refinery Department," "Lubricating Department" and "Marketing Department."

Belting for Grand Coulee Dam Excavation

This carload of "U. S." Matchless Conveyor Belting was the first of several shipments made by the United States



Rubber Company from its Passaic, N. J., factory, to the State of Washington, where the belting will be used in excavating eleven million cubic yards of earth in connection with the building of the Grand Coulee Dam.

Pittsburgh Equitable Opens Memphis Office

The Pittsburgh Equitable Meter Company announce the opening of a new district office at 67 McCall Street, Memphis, Tennessee, effective January 1, 1935.

Z. A. Stanfield, who has represented this company for many years in a sales capacity, has been appointed district manager of the new territory, and will have associated with him J. H. Ferguson and other representatives yet to be announced. The Memphis office will serve the territory comprising the states of Alabama, Mississippi, Kentucky, Tennessee and portions of Louisiana, Georgia and Florida. District headquarters for both the Pittsburgh Equitable Meter Company and its subsidiary, the Merco Nordstrom Valve Company, will be maintained in Memphis.

International Nickel Increases Metallurgical Staff

A. J. Wadhams, manager, development and research, the International Nickel Company, Inc., New York City, has announced the addition of Fred J. Walls to the development and research staff.

Walls will be concerned with the development of the use in industry of nickel cast irons, including the wear-resistant nickel-chromium cast iron, "Ni-Hard," and the high-strength cast iron, "Ni-Tensyliron." His recent connection was with the Eaton Erb Foundry Company in Detroit, and prior to that he carried on an extensive practice as consulting metallurgist in the Middle-West.

Correction

In the November issue of *The Petroleum Engineer* we printed a news item to the effect that Joe Fuller had been appointed North Texas, Louisiana, and Arkansas representative for the France Packing Company, Tacony, Philadelphia, Pennsylvania. This was a mistake, as the France Packing Company has been and still is represented in northern Texas by Paul R. Winston, 608 Construction Building, Dallas. Mr. Fuller represents France Manufacturing Company, Belgrade and Orthodox Streets, Philadelphia, Pennsylvania, makers of France Precision packing.

Annual Conference of Axelson Representatives

In line with a policy established many years ago, eastern representatives of the Axelson Manufacturing Company assembled recently in Los Angeles for yearly conference and study. From Tulsa came Mills Hammett, Eastern and Mid-Continent sales manager, and from St. Louis, Robert Pease, general manager of the St. Louis plant.

These men are spending several weeks with Axelson engineers and metallurgists, going over recent improvements in the Axelson line of pumps and sucker rods.

Sperry-Sun Obtains Sales Rights to H-K Clinograph

The Sperry-Sun Well Surveying Company, Philadelphia, announces that as of January 1, 1935, it obtained the exclusive sales and distributing rights for the H-K, or Hewitt-Kuster, directional magnetic clinograph. As a result, the Sperry-Sun Well Surveying Company can now offer the trade a complete line of well surveying instruments, one for every purpose.

The H-K directional magnetic clinograph introduces a radical improvement and an exclusive method of recording in single readings both the amount and the direction of inclination, utilizing the triangular suspended cross hair plumb bob and floating compass principles, together with a simple, automatically operated and practically fool-proof photograph camera, the manufacturers state.

The H-K clinograph is designed for open holes only. It is lowered into the open hole on a sand or bailing line at a speed ranging from 400 to 800 ft. per minute.

As in the case of the other Sperry-Sun instruments, the Surwel Gyroscopic Clinograph and the Syfo Clinograph, permanent records are made available showing the results.

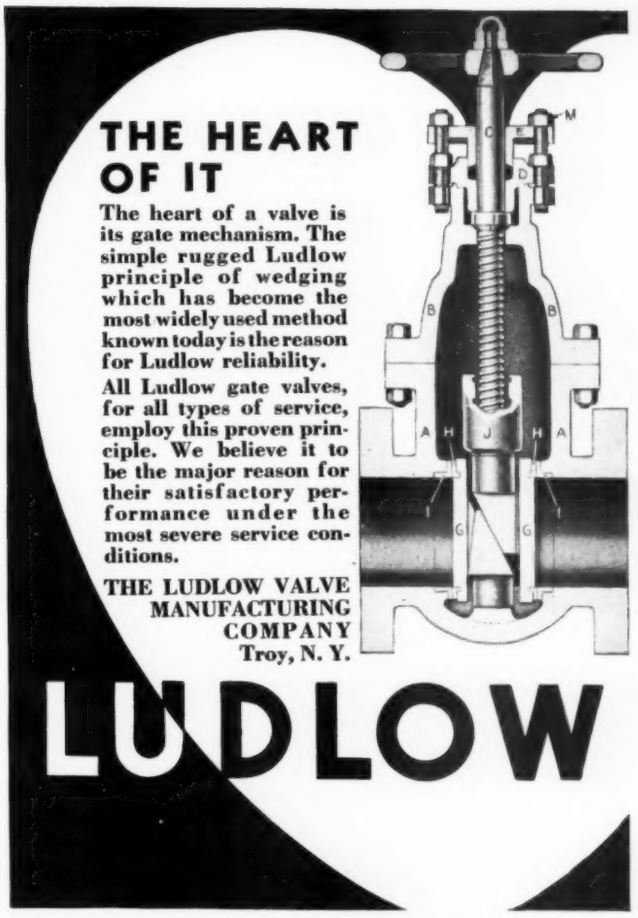
Complete information on this new product can be obtained by writing for a new booklet directly to the Sperry-Sun Well Surveying Company, 1608 Walnut Street, Philadelphia, Pa.

Waukesha Books Large Order for Pumping Units

An exceptionally large order for oil field pumping engines was recently booked by the Waukesha Motor Company of Waukesha, Wisconsin, for use in the California fields. The Fullerton Oil Company, on their lease at Montebello, California, will install 27 pumping units, all made by Waukesha. The Smith-Booth-Usher Company of Los Angeles took the order and a number of the units were delivered from their Los Angeles stock.

The engines are 20-30-hp., Ricardo head, four-cylinder type, arranged for radiator cooling, and drive through a clutch and power take-off. Natural gas carburetors and magneto ignition have been applied, and like other units of this type, they will be installed in the open where they run without attention beyond an occasional inspection for renewal of lubricating oil.

The Waukesha Motor Company also reports a large order for pumping engines to be shipped to South America, this being for 15 pumping units placed by the Standard Oil Company of New Jersey. These engines are 25-35-hp., completely housed independent units with radiator cooling, removable panel side doors, and clutch type power take-off drive. They are mounted on sliding rails and skids for belt adjustment, and are provided with Zenith natural gas carburetors, magneto ignition, air cleaners, oil filters, and other standard accessories.


THE HEART OF IT
The heart of a valve is its gate mechanism. The simple rugged Ludlow principle of wedging which has become the most widely used method known today is the reason for Ludlow reliability.
All Ludlow gate valves, for all types of service, employ this proven principle. We believe it to be the major reason for their satisfactory performance under the most severe service conditions.
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THE LUFKIN RULE CO.
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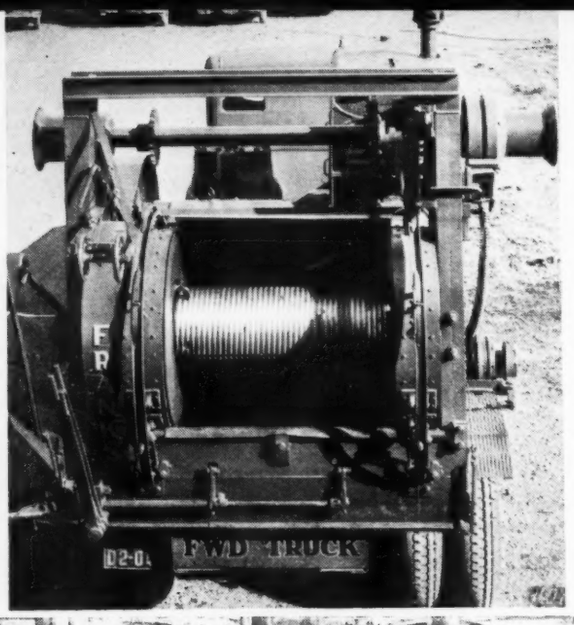
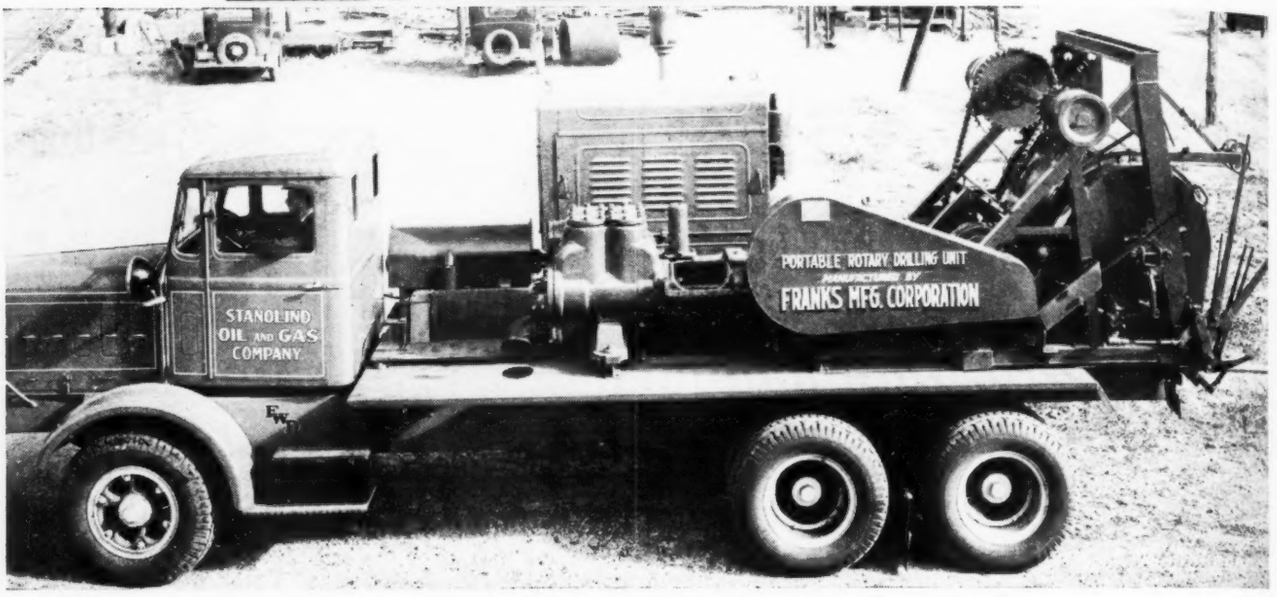


Right: Back end view of truck showing hoist and controls

Below: View showing arrangement of drawworks, engine, pump, and power transmission

Complete S Portable R

By
CARL WHITE, Jr.
Franks Manufacturing Corp.,
Tulsa, Oklahoma



THIS rotary drilling equipment comprises rotary drawworks, complete with standard and automatic cathead, rotary drive, mud pump drive, mud pump, and lighting system, all permanently mounted on a 10-ton four-wheel-drive truck, equipped with six driving wheels and four dead-axle wheels. Motive power is furnished by two identical 125-hp. R. B. Waukesha motors, one mounted independently upon the truck body, the other mounted under the truck hood, and equipped with a split shaft power take-off.

The entire unit has been designed to drill wells to at least 4000 ft. with 3½-in. special full hole drill pipe and thoroughly checked by the research and development engineers of the Stanolind Oil and Gas Company. The specific use of all auxiliary parts furnished by outside manufacturers has been approved.

With the exception of the engine and pump frames, no cast iron is used, all parts being made from cast, forged structural, or high-speed alloy steel. With the exception of the crank and camshaft in the engine, all bearings are enclosed, grease-packed, and self-oiling roller and ball bearings.

Power Take-off

The truck power take-off is of the totally enclosed, split shaft type, mounted on roller and ball bearings.

The drive is through a double 1½-in. pitch roller chain, equipped with both dip and drip lubrication, eccentric shaft type, adjustable idler, mounted on roller bearing throughout, designed for 5000 ft-lb. torque at 1000 rev. per minute.

This take-off box is flexibly mounted behind the truck transmission, universal joints being used both between the truck transmission in front, and the truck transfer case in the rear.

Drive from the truck motor is through parallel shafting, equipped with universal joints, to the second transfer case, identical in design with the chain drive only of power take-off, where the drive is transmitted through a Falk shock-absorbing flexible coupling, through a right angle helical ring gear and pinion drive to the main input shaft of herringbone gear transmission, whose output shaft is the drawworks main countershaft.

Independent Motor

The independent motor is a 6 R.B. Waukesha, 5-in. bore by 5¾-in. stroke, 6-cylinder, the same as that with which the truck is equipped, developing 460 ft-lb. maximum torque, and 125 maximum hp. at 1800 r.p.m. It carries an oversize spring-loaded clutch, combination gas and gasoline carburetor, Vortex air cleaner, and spark proof ignition with self-starter and battery, gas tank, sheet metal steel housing, etc.

Specifications of New Rotary Drilling Unit

The independent motor drives through I.H.C. U-joints, and a 12-C Falk flexible coupling, to a second helical pinion and ring gear to the reverse input shaft of the herringbone transmission gear box.

Right-angle Drives

Working from the independent motor toward the drawworks, the transverse reverse input countershaft carries between the helical pinion and ring gear box and herringbone transmission an 18-tooth sprocket and clutch for driving the cathead shafting, using a 1¾-in. pitch, high-speed roller chain.

This shaft is also equipped with a chain-type flexible coupling connecting to reverse input shaft of herringbone transmission. Working from truck motor drawworks, the transverse main input countershaft carries to the left of right-angle drive case through anti-friction bearing a rotary drive 20-tooth sprocket, cut for 1¾-in. pitch, high-speed roller chain. This rotary-drive sprocket is mounted with a No. 7629 model CC Twin Disc 10-in. 5-dry-plate clutch, carrying a rating almost twice that of the power available from the engine driving same.

To the right of the right-angle drive case, on the transverse main input countershaft, another model CC 10-in. Twin Disc friction cut-off coupling clutch is installed connecting to the main input shaft of the transmission gear case. This clutch is used in compounding the power of the two motors into the transmission case.

Pump Drive

From the independent motor right-angle drive an auxiliary countershaft connects to the transmission gear box reverse output shaft, which carries a 20-tooth double 1½-in. pitch sprocket, with straddle outboard bearings, the drive from the reverse countershaft to the pump sprocket is controlled by another CC Twin Disc 10-in. 5-dry-plate friction cut-off coupling clutch.

Transmission Gear Box

The drawworks drive is through a Franks 1600-ft-lb. herringbone gear transmission, having three forward speeds and a high-speed reverse, as follows:

Low forward	4.23 to 1.00
Intermediate forward	2.01 to 1.00
High forward	1.00 to 1.00
High speed reverse	1.00 to 1.00

The 4-in. face, constant mesh, herringbone gears are made of special alloy heat-treated steel. They are housed in a cast-steel gear box, amply ribbed for strength, and equipped with special oil distributing arrangement.

The main output shaft from this gear box is equipped with a 20-tooth 1½-in. pitch, double-strand, high-speed chain sprocket, for driving the drawworks.

Drawworks

The drawworks drum is 15 in. in diameter, equipped with 36-in. flanges, 40 in. between the flanges, double 8-in. full wrap, self-energizing brakes, Hyatt roller bearings, W-222, capacity 34,000 lb. radial load on 4½-in. Maxel steel shaft, with a $32\frac{3}{16}$-in. OD final-drive friction clutch, the nominal capacity of which is 24,000 lb. direct line pull, on an empty drum barrel, without slipping.

The brakes are lined with 1-in. thick, all-weather, Gatke brake blocks.

The cathead shaft is 4-in. Maxel steel, running on a double-row, self-aligning S.K.F. ball bearing, equipped with a standard cathead on the driller's side, and with a Hill and Foster MJ Junior automatic cathead on the opposite end. The driven sprocket, 41-tooth 1¾-in. pitch, is equipped with a high-speed roller chain. The cathead shaft also carries a 20-tooth 1¾-in. pitch, high-speed roller chain rat-hole sprocket; all are mounted on an A-frame structural steel drawworks, furnished with an 8-in. H-beam head board, including anchorage provisions.

The mud pump is a 7¼ x 10 Gardner Denver, equipped with a 58-tooth 1½-in. pitch, high-speed double strand chain sprocket.

Lighting System

The lighting system is a G.E. 1½-kw. specially designed generator exciter unit, which delivers constant voltage and constant amperage throughout a rotating range from 600 to 3200 r.p.m. It is driven from the truck motor take-off shafting by a 34-tooth driver, and 23-tooth driven sprocket for a ½-in. pitch, high-speed roller chain.

The instrument board at the driller's position carries two tachometers for indicating motor speed when compounding. From these tachometers motor speed, rotary table speed, pump r.p.m. and cathead shaft r.p.m. may be determined.

Truck

The specially designed four-wheel-drive, 125-hp. 6-cylinder R.B. Waukesha motor truck is equipped with dual rear axle, and Westinghouse air brakes. The length of bed space behind the cab is 216 inches.

All drive chains are properly guarded, including rotary drive. Non-slip steel running-boards extend the full length of the truck on either side, providing ample space for the workmen in servicing the machinery.

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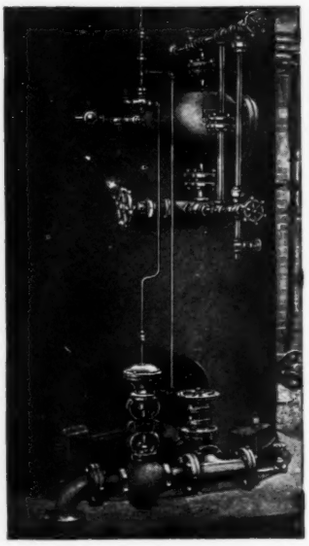

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HOTEL LASSEN
WICHITA, KANSAS

Spang, Chalfant & Co. Make Transfers

Spang, Chalfant & Co., Inc., pipe manufacturers at Pittsburgh, Pa., announce that, effective as of January 1, 1935, Gordon Fisher, Jr., of the Pittsburgh sales department, was transferred to Tulsa, Oklahoma, with offices in the National Bank of Tulsa Building; also A. S. Weaver, formerly located at the Dallas, Texas, office of this company is now located in the Second National Bank Building at Houston, Texas.

GORDON FISHER, JR.

H. E. Rodgers Resigns from Phillips Organization

H. E. Rodgers, formerly technical assistant to the Texas Panhandle division production superintendent of the Phillips Petroleum Company at Whittenburg, Texas, recently resigned, and has opened an office as consulting petroleum engineer at Amarillo, Texas. He also has recently become associated as field manager with the Miller Method Company, which employs the balanced-system for drilling through gas bearing formations. Rodgers is a graduate of the New Mexico School of Mines, holding the degree of geological engineer, and joined the Phillips Petroleum Company at Borger, Texas, in 1926 as field geologist under William L. Clark, and later became district production engineer for the Texas Panhandle district. C. E. Sturdevant was transferred from the Oklahoma City district to succeed Rodgers as technical assistant at Whittenburg.

Jacob Gruber, Oil Man Half Century, Dies

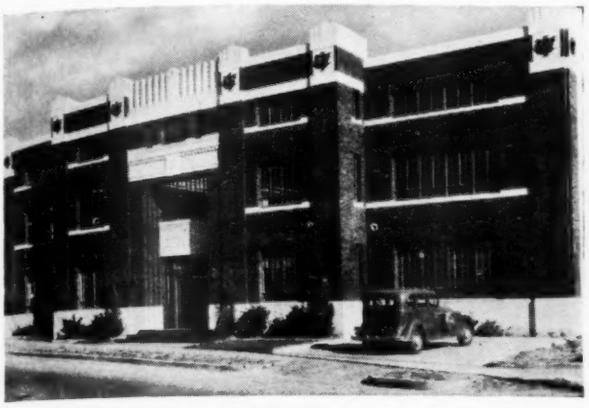
Jacob Mooney Gruber, 81, secretary-treasurer and manager of the Concho Tool & Supply Company of San Angelo, Texas, identified with the oil business for 56 years, died recently at his San Angelo residence. He had been ill since July, angina pectoris proving fatal.

Survivors are the widow, two sons, W. M. Gruber, president of the Concho Tool & Supply Company, and H. R. Gruber of Tulsa, vice-president and sales manager of the Union Wire Rope Company, and three daughters, Mrs. F. M. Roome, of Los Angeles; Mrs. H. C. Bodley, of Chanute, Kansas, and Mrs. Joe F. McGinley, of Ballinger, Texas.

Born in Clarion County, Pennsylvania, February 25, 1853, Mr. Gruber in early manhood was a millwright and began the building of rigs for oil tests in his native state in 1878. In 1909 he moved to Oklahoma and entered the oil well supply business. He was with the Interstate Pipe & Cordage Company at Tulsa for two years, then went with the Muskogee Tool Company in 1915, and to Ranger, Texas, with that concern in 1917. He remained at Ranger for ten years, then became manager of the Union Wire Rope Company at Cisco. He moved to San Angelo from Cisco in November, 1929, and since that time had been secretary-treasurer and manager of the Concho Tool & Supply Company, which was established by his son, W. M. Gruber, in 1928.

Cameron Iron Works' New Headquarters

Cameron Iron Works' new headquarters office, 711 Milby Street, Houston, Texas, is shown above. It was recently completed as one of the most modern oil tool offices in the country, and brings present floor space to 32,000 square feet. It was on this site that Cameron constructed a small shop more than 14 years ago for the manufacture of the original ram-type blowout preventer.



Worthington Establishes Regional Headquarters on the West Coast

The Worthington Company, Inc., recently established a Pacific Coast regional headquarters at Los Angeles, which will center jurisdiction and development of the corporation's business in the western territory now included in the coverage of the Worthington district offices in Seattle, San Francisco, Los Angeles, and El Paso.

This headquarters, under the direction of an executive officer of the corporation, will supplement the efforts of the present district offices and unite with them for the dispatch of business and service to the growing volume of Worthington business in the West. C. E. Wilson, vice-president, is in charge of the Pacific Coast division and accordingly has moved his office from New York to new headquarters at 510 West Sixth Street, Los Angeles.

Precision Bearings Gave Good Performance

The value of precision bearings was demonstrated recently when a large spindle-equipped machine was returned to the makers for an overhaul. This piece of equipment, which has the spindles mounted on Timken bearings, had been in practically continuous operation in an automotive plant for three years. It had operated two shifts a day all the time, and most of the time had been on three-shift operation.

As this was one of the first Timken-equipped spindle machines built by the company, the factory manager was on hand when the spindles were disassembled. His report was that the bearings were perfect, being polished to a mirror finish, and that there was no looseness whatever. These precision bearings were pre-loaded, and the fit showed that the amount of pre-load originally applied was not only correct, but had been maintained through three years of grueling service.

New Account for John H. Baird

John H. Baird, New York and foreign sales representative for several large American manufacturers of oil well equipment, has enlarged his representation to include the Security Engineering Company of Whittier, California, manufacturers of Sievers reamers. Mr. Baird is located in the Graybar Building in New York City.

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INDEX *to* ADVERTISERS

A

Allis Chalmers Manufacturing Co.
American Cable Co.
American Hammered Piston Ring Co. 39
American Lubricator Co.
American Meter Co. 82
American Sheet & Tin Plate Co. 6
American Steel & Wire Co. 63
Anderson, Alexander, Inc. 53
Armstrong Bros. Tool Co. 78
Axelson Manufacturing Co., Ltd. 89
83

B

Baker Oil Tools, Ins.
Baroid Sales Co. 77
Bradford Motor Works 16
Bridgeport Machine Company, The 90
Broderick & Bascom Rope Co.
Byron Jackson Co. 11

C

Cavins Co., The
Chaplin-Fulton Mfg. Co., The 73
Chapman Valve Manufacturing Co., The 88
Climax Molybdenum Co. 1
Continental Supply Co., The 37
Cooper-Bessemer Corporation, The 33
29

D

Dresser, S. R. Manufacturing Co.

E

Eagle-Picher Lead Co.,The
Elliott Core Drilling Co. 3
Ethyl Gasoline Corporation 45

F

Fairbanks, Morse & Co.
First National Bank in Dallas 33
Frick Reid Supply Corp.

G

Gaso Pump & Burner Manufacturing Co.
General Electric Co.
Gott, H. P., Manufacturing Co. 89
Guiberson Corporation 50

H

Hazard Wire Rope Co. 46
Hughes Tool Co. Front Cover
Hydrauger Corporation, Ltd. 89
Hydril Company Back Cover

I

International Harvester Company of America 65

J

Jensen Bros. Mfg. Co.
Jones & Laughlin Steel Corporation
Jones, S. M., Co., The 79

K

Kobe, Inc. 43

L

Landis Machine Co., Inc.
Lane-Wells Co.
Lassen Hotel, Wichita 88
Leschen, A. & Sons Rope Co. 8
Linde Air Products Co. 61
Ludlow Valve Mfg. Co. 85
Lufkin Foundry & Machine Co. 2
Lufkin Rule Co. 85

M

Magnolia Petroleum Co. 16
Martin-Decker Corporation
Mason-Neilan Regulator Co.
Mepham, Geo. S., & Co.
Merco-Nordstrom Valve Co. 16
Metric Metal Works 6
Moore, Lee C., & Co. 31

N

National Supply Companies, The 49
National Tube Co.
National Tube Co. (Stainless))

O

Oil Well Supply Co. 67
O. C. S. Mfg. Co., The
Oxweld Acetylene Co. 61

P

Parkersburg Rig & Reel Co. 75
Patterson-Ballagh Corp. 46
Petroleum Rectifying Co. Inside Back Cover
Pittsburgh Equitable Meter Co. 14
Prest-O-Lite Company, Inc., The 61

R

Reed Roller Bit Co. 4
Republic Steel Corporation

S

Shaffer Tool Works 81
South Chester Tube Co. 71
Sperry-Sun Well Surveying Co. 89

T

Tretolite Company Inside Front Cover
Trimont Manufacturing Co.
Twin Disc Clutch Co.

U

Union Carbide & Carbon Corporation 61
Union Carbide Sales Co. 61
United States Rubber Co.
Union Wire Rope Corporation 5
U. S. Steel Corporation Subsidiaries 50, 63 and 67

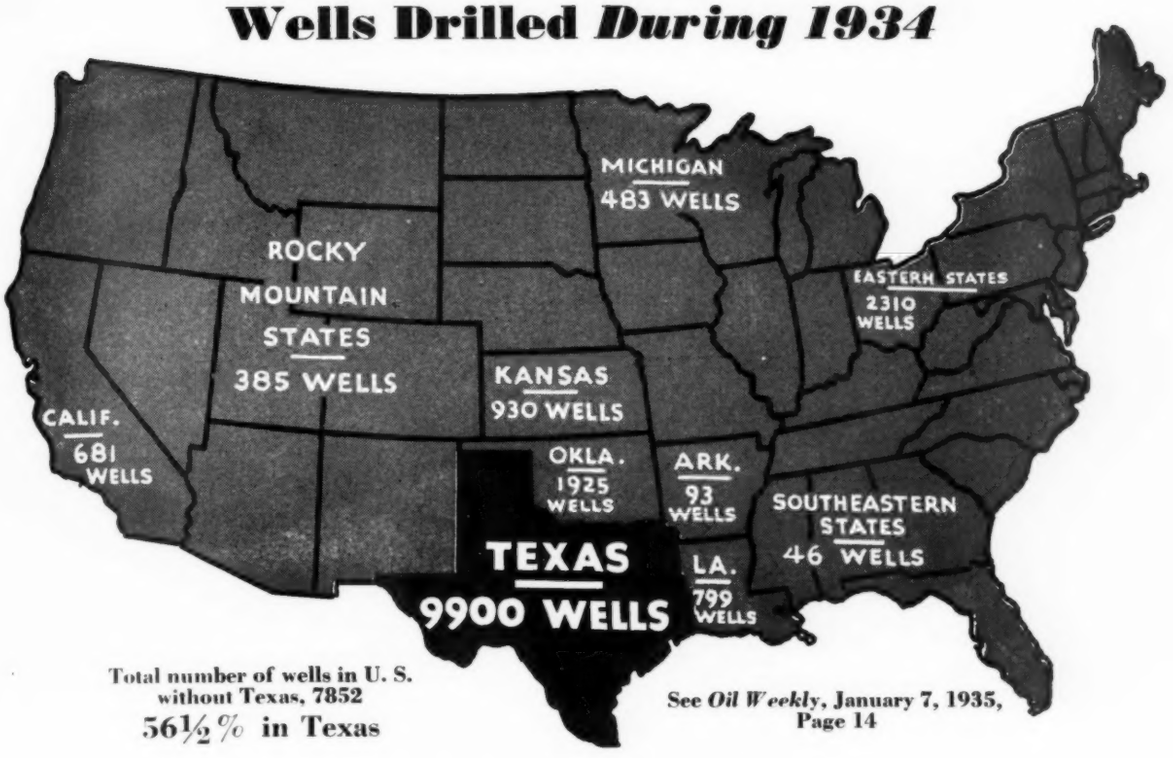
W

Waukesha Motor Co.
Wickwire Spencer Steel Co. 54

Y

Youngstown Sheet & Tube Co. 34

Wells Drilled *During 1934*



Total number of wells in U. S. without Texas, 7852

56½% in Texas

See *Oil Weekly*, January 7, 1935, Page 14

OIL EQUIPMENT AND ENGINEERING EXPOSITION

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APRIL 8-13

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